

***NATIONAL WEATHER SERVICE MANUAL 10-1401***

***Operations and Services***

***Upper Air Program NWSPD 10-14***

***Rawinsonde Observations***

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Date

## RAWINSONDE OBSERVATIONS

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1. Purpose and Scope: Since the late 1930's the National Weather Service (NWS) has measured vertical profiles of pressure, temperature, relative humidity, and wind velocity through the use of balloon-borne radiosondes. This manual defines upper-air operational requirements and procedures applicable to all NWS stations. These instructions cover those sites engaged in taking and reporting atmospheric soundings with Sippican (VIZ), Vaisala Automatic Radio-Theodolite (ART) Radiosondes and the MicroART computer system as well as those sites using Global Positioning System (GPS) radiosondes with the Radiosonde Replacement System (RRS) tracking system.

All aspects of the rawinsonde observation are covered from preparing the radiosonde and flight train to processing and disseminating upper-air data. Also provided are procedures for completing upper-air data forms and maintaining station upper-air equipment. Since operations at each upper-air station can vary, appendices to this manual have been included that may or may not pertain to each office.

This manual does not provide detailed procedures for taking upper-air observations with other NAVAID rawinsondes or with radio-direction finding (RDF) equipment other than the Ground Meteorological Device (GMD) or Weather Bureau Radiotheodolite (WBRT). Observers using other equipment should follow the manufacturers operating instructions.

2. Documentation of Station Upper-Air Program and Facilities: Each upper-air station is responsible for maintaining accurate information files pertaining to its upper-air program. The procedures and responsibilities for documentation of equipment, instrumentation, and observing programs are found in NDS 10-13.

3. Observational Procedures: The procedures and operational requirements defined in this manual apply to all NWS upper-air stations, including those operating under contract, that use the ART radiosondes and the MicroART computer system including those using GPS radiosondes and the RRS tracking system. These procedures have been written to ensure NWS compliance with the observational standards defined in Federal Meteorological Handbook Number 3 and the World Meteorological Organization (WMO) Code Manual 306 Volume I and

## II.

3.1 Times of Observations. Observations from all network stations will be made twice daily, at 0000 and 1200 UTC, unless extenuating and justifiable circumstances prevent it. Actual release times for the 00 and 12 UTC standard scheduled upper air observations should be as close as possible to H-60 minutes, where H is one of the standard times. The release time for a synoptic observation should not fall outside the time range from H - 60 to H + 60, a period known as the release window. For all non-standard observation times, the release window, in regard to the record time of the observation, is from 30 minutes before to 29 minutes after the hour of the assigned observation time.

3.2 Transmission of Observations: The coded message containing data from the observation will be provided to the telecommunication system for dissemination to government agencies and other data users in as timely a manner as possible. The deadlines for transmitting the coded messages are provided in Appendix F, Table F-1 page F-9.

3.3 Recording and Preserving Observations: An archive record of all synoptic rawinsonde observations will be made for submission to the National Climatic Data Center (NCDC). An archive record will also be made of unscheduled observations that are transmitted over telecommunications for use by the government or other data users. The requirements for recording and disseminating these records to the NCDC are described in Appendix I.

4. Official National Weather Service (NWS) Stations: The NWS participates in the WMO's World Weather Watch Program by maintaining and operating a network of rawinsonde stations in the contiguous U.S. (69 sites), Alaska Region (13), Caribbean (1), and (9) Pacific Region. This network of stations comprises approximately ten percent of the global rawinsonde network.

5. Unforeseen Requirements: No set of procedures can cover all possibilities that can occur in an operational setting. The observer must use judgment in adhering as closely as possible to this manual, to handle situations not adequately covered by specific instructions. If procedures in this manual require changes or clarification, suggest them through the site supervisor, who in turn should forward the suggestion to NWS Regional Headquarters. If Regional Headquarters determines the suggestion is appropriate, the Region should forward the suggestion to WSH for possible inclusion into future manual or handbook revisions.

6. Certification of Observers: In order to take official upper-air observations, an observer must be certified in accordance with NWSI 10-1304. The observer must pass a written examination, administered by the office manager, with a minimum score of 80 percent. Each observer must pass an eye examination or show proof of visual acuity of 20/30 or better in at least one eye.

7. Office Responsibilities:

7.1 Upper-Air Station: Rawinsonde observations are essential for producing accurate weather forecasts and warnings. The data also serves other purposes (e.g., aviation operations). Therefore, each observer will ensure observations of the highest quality possible for



dissemination. When there is reason to believe that the accuracy or validity of the upper-air data are questionable or erroneous, follow the procedures outlined in this manual for handling such situations. If ground equipment is believed to be the source of the problem, the observer should notify the electronics technicians for corrective actions.

7.2 Regional Headquarters (RH): NWS Regional Offices will be responsible for overseeing the operations at each upper-air station in their Region. Specifically, they are responsible for the following activities:

- a. Provides assistance in identifying and correcting station problems and coordinating such problems with WSH.
- b. Maintains upper-air station forms, containing station performance and logistical data for a minimum of two years.
- c. Prepares and disseminates quarterly reports of station performance. These reports should include information on average burst heights, failed flights, and second releases.
- d. Develops NWS Supplements related to observing procedures and guidelines.
- e. Conducts periodic station inspections to ensure compliance with the standards and procedures of this manual.
- f. Evaluates the upper-air examination and provides test results to the field sites.
- g. Assists WSH with field tests of new equipment, software, and observational procedures.

7.3 Weather Service Headquarters (WSH): WSH manages the upper-air network through the following activities:

- a. Procures balloons and radiosondes for upper-air stations and maintains pertinent logistical data.
- b. Develops and maintains documentation related to operational upper-air observations. This includes, Policy Directives, handbooks, manuals, training materials, and software installation instructions.
- c. Maintains, makes, and tests necessary changes to upper-air software.
- d. Prepares reports on overall station and network performance.
- e. Develops specifications for all equipment, from balloons and radiosondes to ground tracking and data processing systems.

- f. Laboratory and field tests the operational performance of all equipment.
- g. Conducts upper-air station assistance visits.
- h. Prepares and maintains the upper-air observer certification exams.

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## APPENDIX A – RADIOSONDE FAMILIARIZATION

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1. Introduction: The purpose of this appendix is to familiarize observers on the operation and handling of radiosondes and the NWS ground systems used to collect, process, and disseminate the upper-air data. NWS currently uses two types of radio direction finding (RDF) radiosondes: the Vaisala RS-80-57H and the Sippican VIZ-B2. These radiosondes are tracked with an ART (WBRT or GMD) system. The NWS also is transitioning to GPS radiosondes with the Radiosonde Replacement System (RRS) tracking system. The initial GPS radiosonde is the Sippican MkIIA. Each radiosonde manufacturer has prepared step-by-step instructions for preparing their radiosondes for flight. The observers should follow these instructions and those provided in Appendix E while preparing a radiosonde for flight. Appendix N provides the radiosonde preparation instructions for the RDF and GPS radiosondes.

The radiosonde is a small, expendable instrument package that is suspended below a large balloon filled with hydrogen or helium gas (see Appendix C - Balloon Familiarization for more information on balloons used and their handling). As the radiosonde ascends, sensors on the radiosonde measure the pressure, temperature, and relative humidity (RH). These sensors are linked to a battery powered radio transmitter that sends the sensor measurements to a sensitive ground receiver at 1 to 2 second intervals. While in flight, the ground system tracks the position (i.e., angular bearing) of the radiosonde. This information is used to derive wind speed and direction aloft for the RDF tracking systems while the RRS tracking system uses GPS to

determine wind speed and direction. A computer is used to process, encode, and disseminate the data.

The radiosonde flight can last in excess of two hours. During this time the radiosonde can rise over 30 km and drift more than 200 km from the release point. During the flight, the radiosonde is exposed to temperatures as cold as -95° C, RH values ranging from 0 to 100%, and air pressures only a few thousandths of what is found at the Earth's surface.

When the balloon has expanded beyond its elastic limit and bursts (typically 7.4 to 9.8 meters in diameter), a small parachute slows the descent of the radiosonde, minimizing the danger to people and property. Twenty percent of the approximately 75,000 radiosondes released by the NWS each year are found and returned for reconditioning. These reconditioned radiosondes are reused, saving the NWS the cost of a new instrument.

2. Radioonde Inspection: The observer will physically inspect the instrument before proceeding with an observation. If broken, missing, discolored, or misshapen components are detected, the instrument will be rejected and another instrument used. DO NOT ATTEMPT TO REPAIR THE INSTRUMENT. Section 3 provides additional information on what to look for when inspecting radiosonde components for defects.

3. Radioonde Components: Radiosondes are delivered from the National Logistics Supply Center (NLSC) to the upper-air station assembled and ready for flight. The following components make up the Radioonde instrument:

- a. Pressure, temperature and RH sensors measure the environment as a function of changes in sensor electrical parameters such as resistance or capacitance.
- b. A radio transmitter for telemetering sensor measurements to ground receivers.
- c. A battery for powering the electronic components.

All the electronics and some of the sensors are housed within a waterproof casing made of lightweight, durable materials. A mailing bag is included with the instrument so that it can be returned for reconditioning. Total instrument weight ranges from less than 250 grams (Vaisala) up to 500 grams Sippican (VIZ).

Within each box of RDF radiosondes, a floppy diskette is enclosed that contains calibration data for each radiosonde. The Sippican MkIIA GPS radiosonde does not require a calibration diskette. It transmits the calibration data during baseline. The calibration data applies numerical constants and other calibration factors to the raw pressure, temperature, and RH data to ensure sensor accuracy. Appendix A of the MicroART Training Guide provides procedures for loading the Calibration data into the MicroART computer.

3.1 Pressure Sensor (Capabilities and Limitations): Both Vaisala and Sippican (VIZ) radiosondes use a capacitance aneroid cell to measure atmospheric pressure. The cell is a metallic, wafer-shaped capsule with a partial vacuum. As the pressure changes, the cell expands (decreasing pressure) or contracts (increasing pressure), changing the separation between two plates contained inside the capsule. The pressure is determined by measuring the changing electrical capacitance between the plates. There are no springs, arms, or contacts as was common in older pressure sensor designs.

On both radiosonde types, the pressure sensor is located within the instrument packaging and is not readily visible. Do not attempt to open the radiosonde to view the pressure sensor.

The capacitive aneroid typically has an accuracy of about 0.5 hPa (with decreasing accuracy aloft), and a measuring range from 1060 to 3 hPa. It has excellent response time to rapidly changing pressures (less than a second). The capsule can occasionally leak during a flight (usually above 15 km) causing abrupt changes in pressure and consequently unrealistically high ascension rates and heights. Moreover, during radiosonde preparation, the pressure sensor may provide out of tolerance readings and should be rejected. Procedures for handling these situations are provided in Chapter 8 of the MicroART and RRS Training Guide.

3.2 Temperature Sensor: Vaisala and Sippican (VIZ) radiosondes employ temperature sensors with different characteristics and limitations. Information on each type of sensor is provided below:

3.2.1 Vaisala: A "Thermo cap" mounted on a flexible boom outside the radiosonde package is used to measure temperature. The thermo cap is a small bead that contains a capacitor that changes its electrical capacitance as a function of temperature. The sensor is coated with an aluminum coating to minimize solar and infra-red radiation.

If a thermo cap is chipped, discolored, or damaged, reject the instrument and use another.

3.2.2 Sippican (VIZ): Temperature is measured on the VIZ B2 radiosonde by the thermistor which is a small, thin rod comprised of baked clay and iron fillings. The sensor or "thermistor" measures temperature by the change in electrical resistance across the rod caused by changing temperature. A thermistor is mounted on the end of a flexible boom outside the radiosonde package.

If a thermistor is chipped, discolored, or damaged, do not attempt to repair or replace the sensor. The observer will reject the instrument and use another.

The Sippican Mark IIA GPS radiosonde uses a chip sensor at the end of the sensor boom. The only adjustment allowed is if the wire leads are bent, the operator may gently re-position the leads to their original configuration in accordance with the Sippican Mark IIA Radiosonde Preparation Instructions.

3.2.3 Sensor Capabilities and Limitations: Vaisala and Sippican (VIZ) temperature sensors have an accuracy of about  $\pm 0.3^{\circ}\text{C}$  in the troposphere and a very good response time to changing temperatures (generally less than 4 seconds). They are designed to operate over a temperature range of  $-90$  to  $+50^{\circ}\text{C}$ .

If the thermo cap or thermistor is exposed to wet conditions during a flight, the "wet bulb" effect may occur causing excessive cooling in the temperature measurements. Chapter 14 in the MicroART Training Guide and Chapter 13 in the RRS User Guide provide procedures for handling temperature soundings when the wet bulb effect occurs and for other temperature data anomalies.

Both temperature sensors are affected to some extent by long-wave (infrared or IR) and shortwave ultraviolet (solar) radiation. The effect on the data is to cause the sensor to report a different measurement than is truly representative of the atmosphere.

During the daytime (i.e. when the sensor is exposed to sunshine), solar radiation is absorbed by the sensor causing it to read higher than the ambient temperature. The solar error varies with the solar elevation angle, with a minimum at low angles. At night, the solar effect is zero.

During day and night, the sensor radiates and absorbs long wave energy to and from its surroundings (i.e. space, ground, clouds, atmosphere, etc.) proportional to sensor temperature and the temperature of the surroundings. The long-wave error usually results in temperature readings lower than ambient but may lead to a positive error under some conditions.

The Sippican (VIZ) thermistor is coated with white paint to reduce the effects of solar and infrared radiation, but it does not adequately lessen these effects at high altitudes. At altitudes above 16 km the temperature error can exceed  $1^{\circ}\text{C}$ . Observers will not correct or edit these data to correct for solar or the effects of infra-red radiation before dissemination. The National Center for Environmental Prediction (NCEP) and other users will apply the necessary corrections to the VIZ B2 radiosonde.

The Sippican Mark IIA GPS radiosonde has a solar radiation correction applied by the RRS software. This does not however, preclude the observer from editing or deleting temperature data that is obviously bad due to a sensor error. Vaisala coats its sensor with an aluminum coating and the temperature measurements are partially adjusted for radiation effects while being pre-processed in the MicroART SPU-11 computer card.

3.3 Relative Humidity Sensor: As with their temperature sensors, Vaisala and Sippican (VIZ) employ different technology for measuring RH. Both techniques are described in the next 3 sections:

3.3.1 Vaisala: The "Humicap" is located on the radiosonde boom beneath the thermo cap. This sensor measures RH as a function of changing electrical capacitance. Between the capacitor plates is a thin polymer film that expands or contracts with changing RH and changes the

electrical capacitance between the plates. The sensor is covered with a small, aluminum-coated plastic cap to shield it from solar radiation and precipitation.

Never remove the cap covering the RH sensor. If the cap is discolored, misshapen, or missing, reject the instrument and use another. If the cap has fallen off the humidity sensor, it may be placed on the sensor using a paper towel or cloth to avoid oil from the skin contaminating the sensor.

**3.3.2 Sippican (VIZ):** Sippican (VIZ) employs a "hygristor" to measure RH. The hygristor is a rectangular strip of plastic which has been dipped in a liquid mixture of carbon particles and celluloid resin and then dried. The celluloid is sensitive to RH and expands or contracts with the amount of water vapor in the air. This fluctuation causes the distance between the carbon particles to vary and thus the electrical resistance across the strip.

To protect the sensor from precipitation and solar radiation, the hygristor is housed within a curved, black laminated (to reduce reflected solar radiation) duct that is built into the styrofoam radiosonde case.

The hygristor comes packed in a metallic container. During pre-flight procedures, it is removed from the container and installed into the duct. If the sensor is damaged (e.g., scratched during installation), misshapen, or discolored, select another sensor and enter the calibration data into the Radiosonde Data screen.

The RRS humidity sensor is enclosed in a metal cap attached to the side of the radiosonde. Refer to Appendix N for the proper procedures for handling the sensor. If the sensor is damaged (e.g., scratched during installation), misshapen, or discolored, reject the radiosonde.

**3.3.3 Sensor Capabilities and Limitations:** Both sensor types provide RH measurements from 0 to 100%. The accuracy of the sensors is about  $\pm 5\%$  and the response time is in seconds. However, at temperature below  $-30^{\circ}\text{C}$  the response time of these sensors can exceed 2 minutes and their accuracy is not fully established.

The Humicap can provide erroneous readings if the sensor becomes coated with water or ice as it ascends through a cloud. The result is RH readings that are biased too high. Refer to MicroART Chapter 14 and Chapter 13 in the RRS User's Guide for procedures on how to handle such data and other RH data anomalies.

Both sensors are affected by hysteresis. Hysteresis is characterized by the sensor's inability to correctly react to changing RH profiles such as when the radiosonde exits a cloud (i.e., the RH drops rapidly from near 100% RH to a much drier value). The RH error caused by hysteresis can exceed 10%. Chapter 14 of the MicroART Training Guide and Chapter 13 of the RRS User's Guide provide procedures for handling RH data resulting from this effect.

### 3.4 Radio Transmitter and Battery:

3.4.1 Radio Transmitter: The radio transmitter electronics used on both types of NWS radiosondes transmits data pulses that represent one of the radiosonde sensor measurements or an internal electrical reference. The data are transmitted in a repetitive cycle of pressure, temperature, RH, and reference measurements. This produces a sampling rate of about 1-2 seconds for each of the radiosonde sensors.

The transmitter power is 250-350 milliwatts with an amplitude modulated frequency that can be manually tuned from about 1660 to 1710 MHz. This power is sufficient for the ground system to receive the signal at distances exceeding 250 km.

The transmitter is housed inside the radiosonde casing to protect it from the elements. Do not open the casing to view the transmitter components. Follow the radiosonde preparation instructions in Appendix N for handling the instrument and tuning it to the proper operating frequency.

3.4.2 Battery: For all types of NWS radiosondes, a water-activated battery is used for generating power to operate the radiosonde. The battery is not factory installed and is wrapped in foil or plastic. To activate the battery, remove from the battery package and soak it in water for the prescribed time. After activation, the battery is placed inside the radiosonde casing and will provide adequate power for up to 135 minutes.

It is very important to follow the battery preparation instructions provided in Appendix N to ensure optimal flight performance.

It is essential for the batteries to reach proper voltage prior to baseline. The Sippican Mark IIA GPS radiosonde battery should be connected to the instrument a minimum of 5 minutes prior to initiating baseline to ensure the minimum 5.6 voltage has been achieved.



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\1. Introduction: The meteorological community utilizes several modes for radiosonde tracking. The NWS in the past used primarily radio direction finding (RDF) because it had the least expensive types of radiosondes to meet operational requirements. The ART relies on a number of mechanical and electrical parts which must be kept precisely calibrated.

Some locations were not suited for the placement of a RDF system for a number of reasons. The relatively massive size of the RDF requires attention to property availability, zoning ordinances, and support structure suitability. In addition, some locations are prone to interference in the RDF's band of operation. For these reasons, and others, some sites operate a smaller receiving system that relies on specially designed radiosondes. These tracking systems use radio-navigational techniques to track the radiosondes and obtain winds aloft information.

There are three NWS stations in the Eastern Region that will continue to use the ground based U. S. Coast Guard Long Range Navigation (LORAN) Omni-directional transmitters. LORAN

requires virtually no moving parts. Tracking is dependent on a LORAN radiosonde that determines its position through triangulation with at least three LORAN ground stations.

The Automated Radio Theodolite (ART) will be replaced by a tracking system using the Global Positioning System (GPS). It is because of the difficulty in finding replacement parts for the ART tracking system and its less precise wind tracking accuracy that the NWS has decided to change to GPS tracking. This method is becoming a cost effective means to independently observe the atmosphere in remote locations anywhere across the globe.

## 2. ART System Description:

2.1 ART Subsystems: The ART RDF system is housed within a 4.5 meter white fiberglass protective radome atop a balloon inflation building (Figures B-1 and B-2). The system is comprised of the receiving antenna, the radio-frequency (RF) assembly, and the receiver antenna control unit.

The primary purpose of the receiving antenna is to receive the radiosondes transmitted carrier frequency and the embedded data signal. The system is comprised of either a 2.3 or 3.0 meter diameter parabolic antenna, connecting shaft, secondary reflector, and dipole antenna (Figures B-3 and B-4). The main dish reflects signal energy to the secondary reflector, a .3 meter diameter cup that rotates on an offset axis. The rapid rotary motion of the secondary reflector gives a scan pattern that is best described as a narrow cone. Conical scanning enables the system to reliably track a radiosonde with an automatic gain control process.

Radiosonde position can be measured accurately to within hundredths of a degree.

The RF assembly is housed on the backside of the tracking dish. The purpose of the RF assembly is to screen extraneous RF energy, and to selectively pass, filter, mix, and amplify the radiosonde carrier signal to create an intermediate frequency (IF) of 60 MHz. Next, the IF signal is routed to a second mixer and is amplified with information from the automatic gain control circuit. After an additional sequence of events, an IF signal of 10.7 MHz is produced. The IF signal is then processed by the receiver circuits within the receiver/antenna control unit (R/ACU). (Figure B-5)



Figure B-1 - NWS High-Bay Upper Air Shelter



Figure B-2 - NWS Low-Bay Upper Air Shelter





Figure B-3 - GMD Antenna/Pedestal Assembly (ART-1)

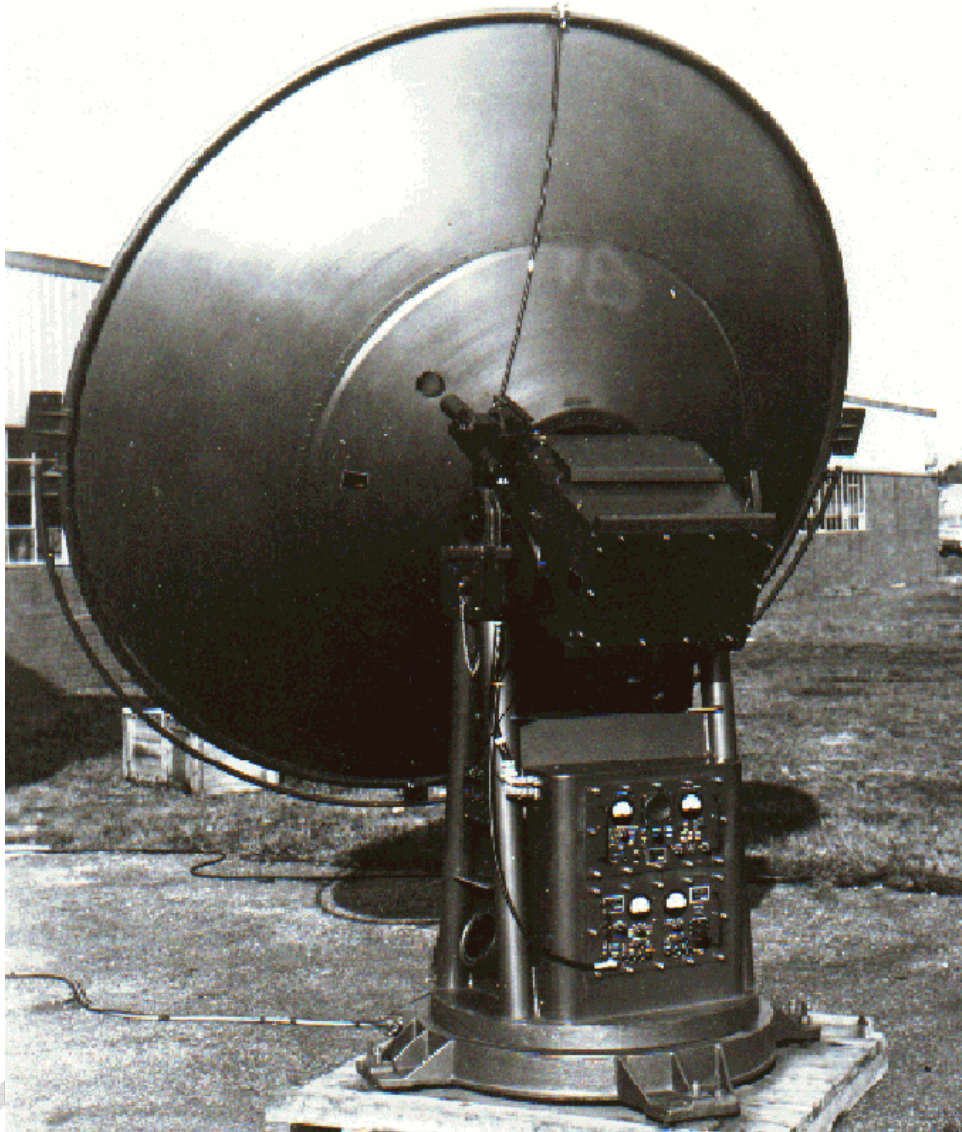


Figure B-4 - WBRT Antenna/Pedestal Assembly (ART-2)

The R/ACU is housed within a large box at the top of the antenna pedestal near the fulcrum of the parabolic tracking dish. In the R/ACU, two major signal processes occur. One is the extraction of the meteorological signal and the other is the creation of automatic gain control information for use in the RF assembly. The R/ACU also contains circuitry to digitize drive gear positional information, transmit commands to the drive gears, and to distribute status conditions (signal and position data) to the three control panels.



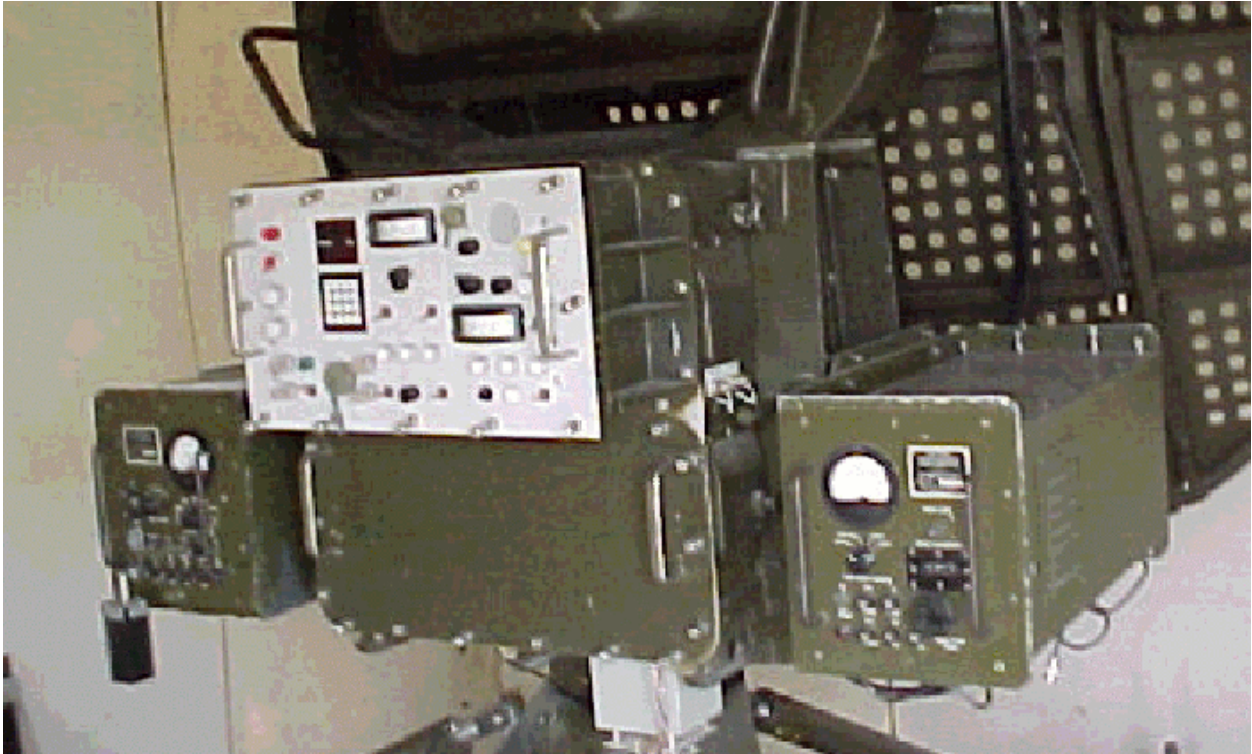


Figure B-5 - The Antenna/Receiver Control Unit

2.2 ART Operational Limitations: The ART system should maintain proper signal lock with the radiosonde until the radiosonde flies beyond the horizon or flies behind a zone of near-field objects. The ART system might lose its lock on the signal if the received signal becomes seriously degraded from multipathing (splintering) about obstructions within the near or far ranges. Signal degradation can occur when the radiosonde moves within a six degree margin of the edge of obstructions. The ART tracking lobe is six degrees.

Observers should recognize the ART system's inability to distinguish between the transmitter's main lobe (true signal) from the radiosonde transmitter's ever present side-lobes. A side-lobe can give an azimuth discrepancy of as much as 30°. When the system gains a lock with a side-lobe not only is the detected position in error, but the variable nature of the side-lobe's signal might lead to significant tracking disruptions and loss of data. To avoid tracking a side-lobe, check the remote control panel and master control unit for weak, jumpy, or intermittent signal strength. If detected, take immediate action to find a more stable and stronger signal indicating acquisition of the main signal lobe. Another indication would be an inexplicable change in azimuth bearing (e.g., 5° or more in 10 sec).

2.3 Azimuth Convention - The Home Bearing: Tracking systems identify radiosonde position with azimuth angles that are expressed as the compass bearing back toward the ground tracking station. For example, when winds are from due south throughout the atmosphere, the rawinsonde will fly northward, producing a 180° bearing. The Master Control Console displays 180° as the



azimuth angle, or *home bearing*, of the radiosonde.

The ART tracking hardware is maintained true with respect to its baseline orientation setting. For elevation angle accuracy, the pedestal (outrigger) equipment is leveled and set to 0.00 degrees. Similarly, the azimuth scale is set to 0.00 degrees based on true north. All components of the tracking system are maintained to give precision measured in the hundredths of a degree.



Figure B-6 - Master Control Console (Full Rack Assembly)

## 2.4 ART System Control Positions:

2.4.1 Master Control Console: The ART system operations are most often conducted in the office at the master control console. This master assembly (Figure B-6) is identified as the Servo Automatic Radio-Theodolite Data Control Assembly. It is comprised of the Power Control, Angle/Time Display, and the Master Control Unit Panels.

2.4.2 Power Control Panel: On the Data Control Assembly is two circuit breakers; the main breaker (red panel) is on left side and the service breaker (black panel) is on right side. The ON/OFF power button starts the ART system.

2.4.3 Angle/Time Display Panel: An illuminated red digital LED readout displays bearing angle, elevation angle, current time, and elapsed time information. With the power control panel on, the Angle/Time Display should always show the correct time and antenna position regardless of antenna or receiver operational status.

2.4.4 Master Control Unit Panel: The bottom panel of the master control console is the Master Control Unit (MCU). The leftmost side displays status information and gives control for powering the antenna/receiver unit. The MCU central section is a control point for the selection of tracking mode. From this section, MicroART data processing will be started with a push-button release switch (Item #13, Figure B-8). To the right side, are two meters that continually display received signal strength and frequency. Also in this section, is a control point for the selection of search mode and the adjustment of receiver's frequency.

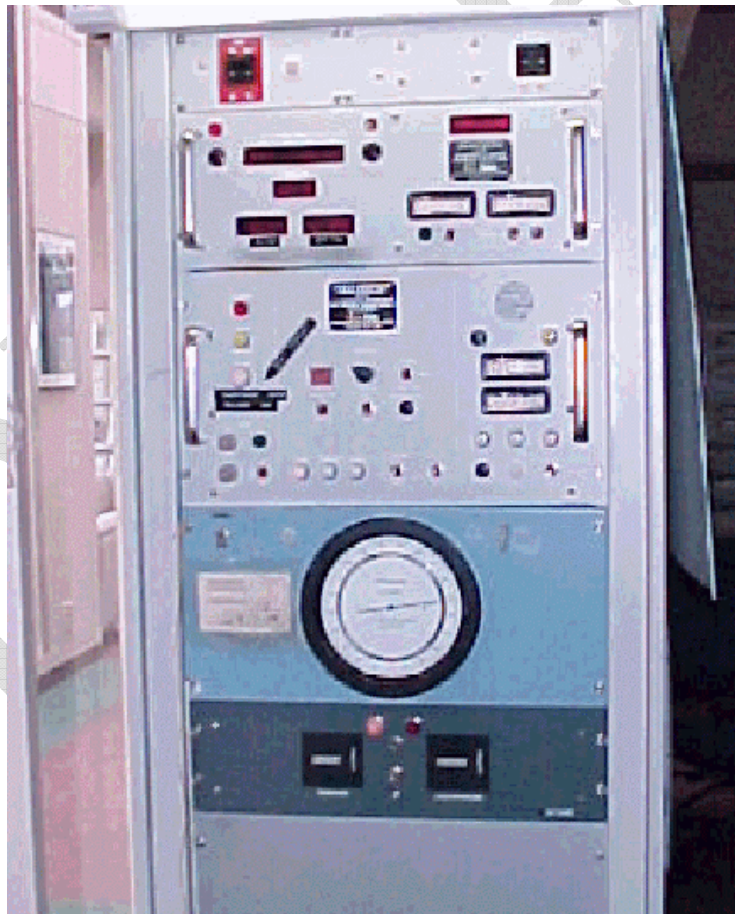


Figure B-7 - Master Control Unit

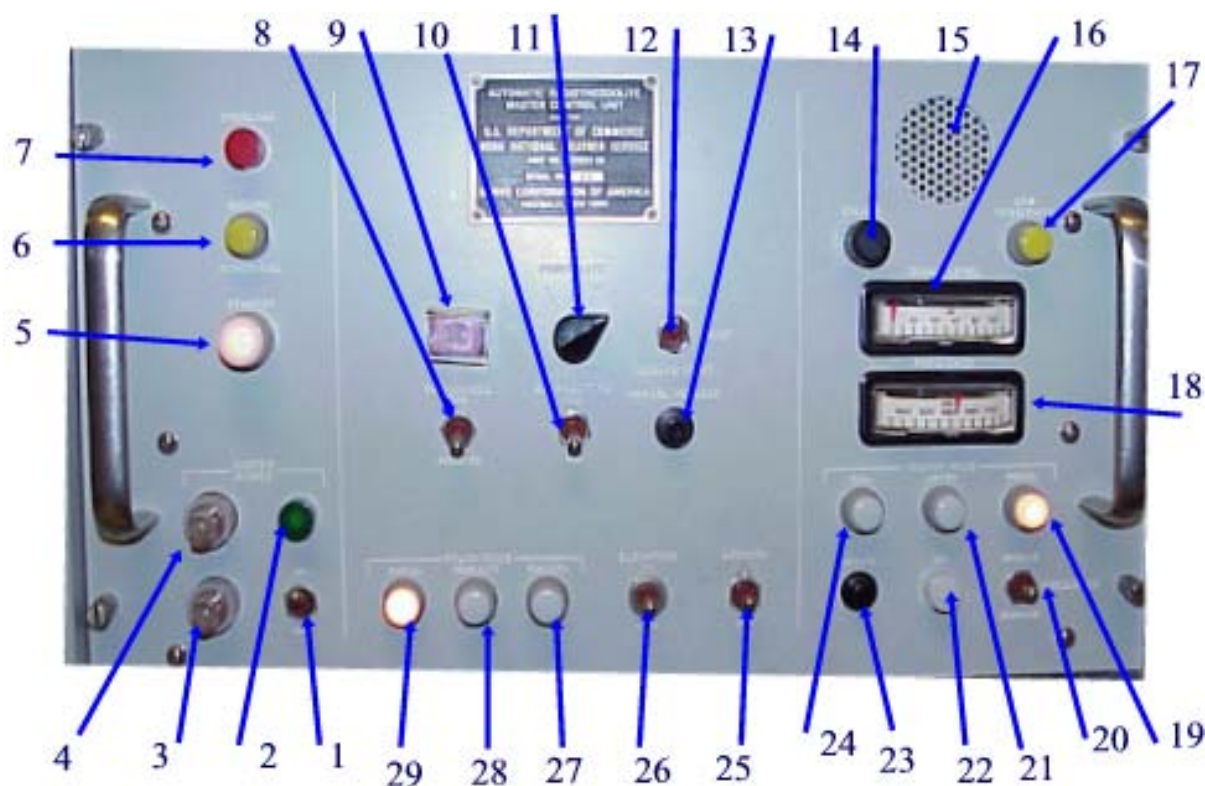


Figure B-8 - Master Control Unit Close-Up  
(Arrowed numerals correspond to functions listed in Table B-1)

Table B-1 - Master Control Unit - Numbers corresponds to the respective controls in Figure B-8

No.	Master Control Unit (MCU)	Function
1	ON/OFF Switch	Entire ART System
2	INDICATOR	Green lamp is lit if master ON/OFF is set ON and if In-Radome REC/ANT control panel is set To ON.
3	2 AMP Fuseholder	When Fuse F1 is blown, neon lamp glows amber.
4	2 AMP Fuseholder	When Fuse F2 is blown, neon lamp glows amber.
5	STANDBY (Indicator Switch)	White button switch. Azimuth and elevation drives and scan motor can be toggled on/off.
6	RADOME/POWER FAIL	Yellow button indicator/reset switch will alert you to the general state of radome power (on/off).
7	OVERLOAD	Red button lights when the azimuth or elevation drives get overloaded. (If overload occurs, the drives automatically de-energize.)

8	RADIOSONDE (Switch)	No longer used. The switch should be left in the Time position (Up) as the default.
8	RADIOSONDE (Switch)	No longer used. The switch should be left in the Time position (Up) as the default.
9	STOP PRINT	Red button switch stops the elapsed time on the Ang/Time LED display.
10	ELAPSED TIME	Toggle switch. When in RUN position (down) it displays the elapsed time. The HOLD position (up) stops the running display, but keeps the clock incrementing (can restore running display with RUN command).
11	PRINT RATE	Used with the wind data printer-Allows the print rate to vary. Useful when doing optical comparisons.
12	PRINT	This function has no effect on the MicroART workstation. It will affect the wind data printer if used at the site.
13	MANUAL RELEASE	Black momentary push-button, when pressed sends release signal to start the ELAPSED TIME Display and starts data capture.
14	VOLUME	Black knob adjusts the audio level of the loudspeaker.
15	LOUDSPEAKER	Produces an audible sound of incoming MET data and release tones.
16	SIGNAL LEVEL	A meter that displays the incoming signal level from 0 to 100 db in 10 db increments.
17	LOW SENSITIVITY	Yellow push-button toggle switch puts the receiver into a low sensitivity mode. [When SYSTEM POWER switch is set ON (Yellow button is lit), the receiver is automatically set to low sensitivity.]
18	FREQUENCY METER	Displays frequency 1655-1705 MHZ in 5 MHZ increments. Intermediate values are interpolated.
19	SEARCH MODE – MANUAL	White push-button switch when pressed (illuminates) puts the receiver into MANUAL SEARCH MODE.
20	FREQUENCY	Toggle switch is usually off (neutral). Used in MANUAL SEARCH mode. When in INCREASE position (up) the receiver frequency (MHZ) is increased when in DECREASE position (down) the receiver frequency (MHZ) is decreased.
21	SEARCH MODE – LIMITED	White push-button switch when pressed (illuminates) puts receiver into LIMITED SEARCH mode.

22	AFC Indicator	White indicator lamp. Lamp illuminates when system is locked-on to a received signal.
23	INITIATE	Black push-button (momentary) switch when FULL SEARCH MODE switch is illuminated and switch is pressed the receiver is put into FULL SEARCH MODE.
23	INITIATE	Black push-button (momentary) switch when FULL SEARCH MODE switch is illuminated and switch is pressed the receiver is put into FULL SEARCH MODE.
24	SEARCH MODE - FULL	White push-button switch when pressed (illuminates) and system is capable of being put into FULL SEARCH MODE via the INITIATE switch.
25	AZIMUTH	Toggle switch is usually off (neutral). Can be used in all track modes. When in CW position (up) the tracking dish turns through the compass in a CW direction. When in CCW (down) dish turns in CCW direction.
26	ELEVATION	Toggle switch is usually off (neutral). Can be used in all track modes. When held in UP position (up), the dish increases its elevation angle. When in DOWN (down), the elevation angle of the dish is decreased.
27	TRACK MODE – FAR AUTO	White push-button switch when pressed (illuminates) makes system tracking automatic for tracking a balloon with slow angular changes.
28	TRACK MODE – NEAR AUTO	White push-button switch when pressed (illuminates) makes system tracking automatic for tracking a balloon with rapid angular changes.
29	TRACK MODE – MANUAL	White push-button when pressed (illuminates) disengages system from automatic tracking and places system into manual track mode. USE toggle switches to adjust the antenna position in elevation and azimuth for tracking the balloon.

**NOTE for # 5: CAUTION should be exercised in use of the STANDBY switch. Repeated overloading indicates malfunctioning equipment. Repeated overloading and resetting could cause costly damage to the equipment.**



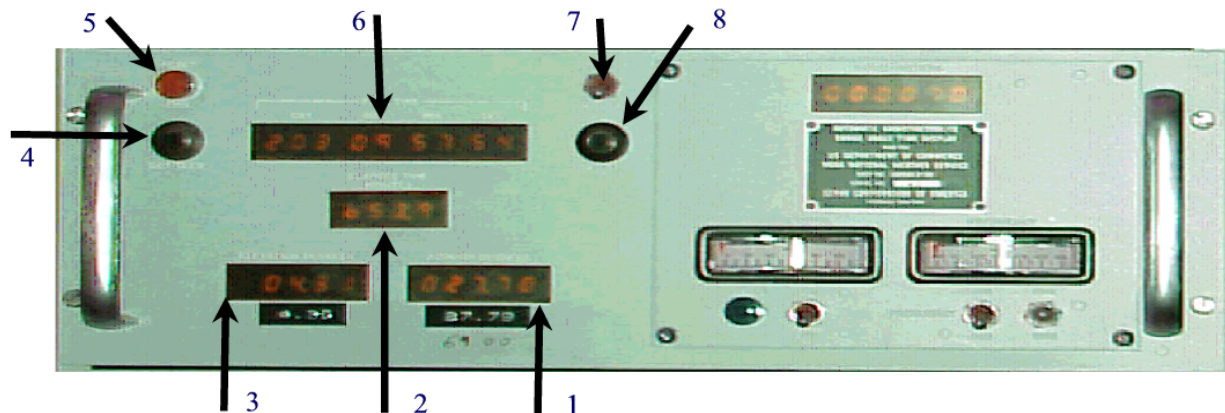


Figure B-9 - Angle/Time Display

Table B-2 - Angle/Time Display Rack - Number sequence corresponds to the respective controls in Figure B-9.

No.	ANGLE / TIME CONTROLS	FUNCTIONS TO DISPLAY ANGLE / TIME
1	ELEVATION DEGREES	Red LED display gives tracking dish angles from -5° to +95° in 0.01° increments.
2	ELAPSED TIME MINUTES	Red LED display gives time from the launch, when release button was pressed, in 0.1 minute (six second) increments.
3	AZIMUTH DEGREES	Red LED display gives the tracking dish azimuth angle from 0° - 360° in 0.01° increments.
4	DAY SLEW	REAL TIME DAY display - Two-step button, when partially depressed slowly slews. When fully depressed, slews rapidly.
5	RESET TIME	Red button indicator illuminates when power is interrupted and the REAL TIME might be incorrect.
6	REAL TIME	Red LED display gives REAL TIME in days, hours, minutes, and seconds {UTC}.
7	TIME-SET/INHIBIT	Toggle switch. When TIME-SET is selected, use the TIME SLEW and DAY SLEW switches to change the real time. When in INHIBIT the slew switches are inoperative.

8	TIME SLEW	Two-step button, when partially depressed slowly slews the REAL TIME display, when fully; it rapidly slews the displayed REAL TIME.
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2.5 Remote Control Panel: The remote control unit is an all-weather control panel mounted outside the inflation shelter. The panel is used to synchronize ART electronics and MicroART data processing with the exact launch time. This may be initiated by pressing the release button (#6, Figure B-11), or by using the timed release option that has a 60 second timed delay (#5, Figure B-11). The timer generates an audible series of preliminary tones and concludes with a tone for the observer to release the balloon. The remote control unit is fully integrated with the tracking system atop the inflation shelter. The remote panel is a control position for each of the receiver and antenna operational modes and includes a manual override for each.



Figure B-10 - Closed Remote Control Panel with Rain Cover

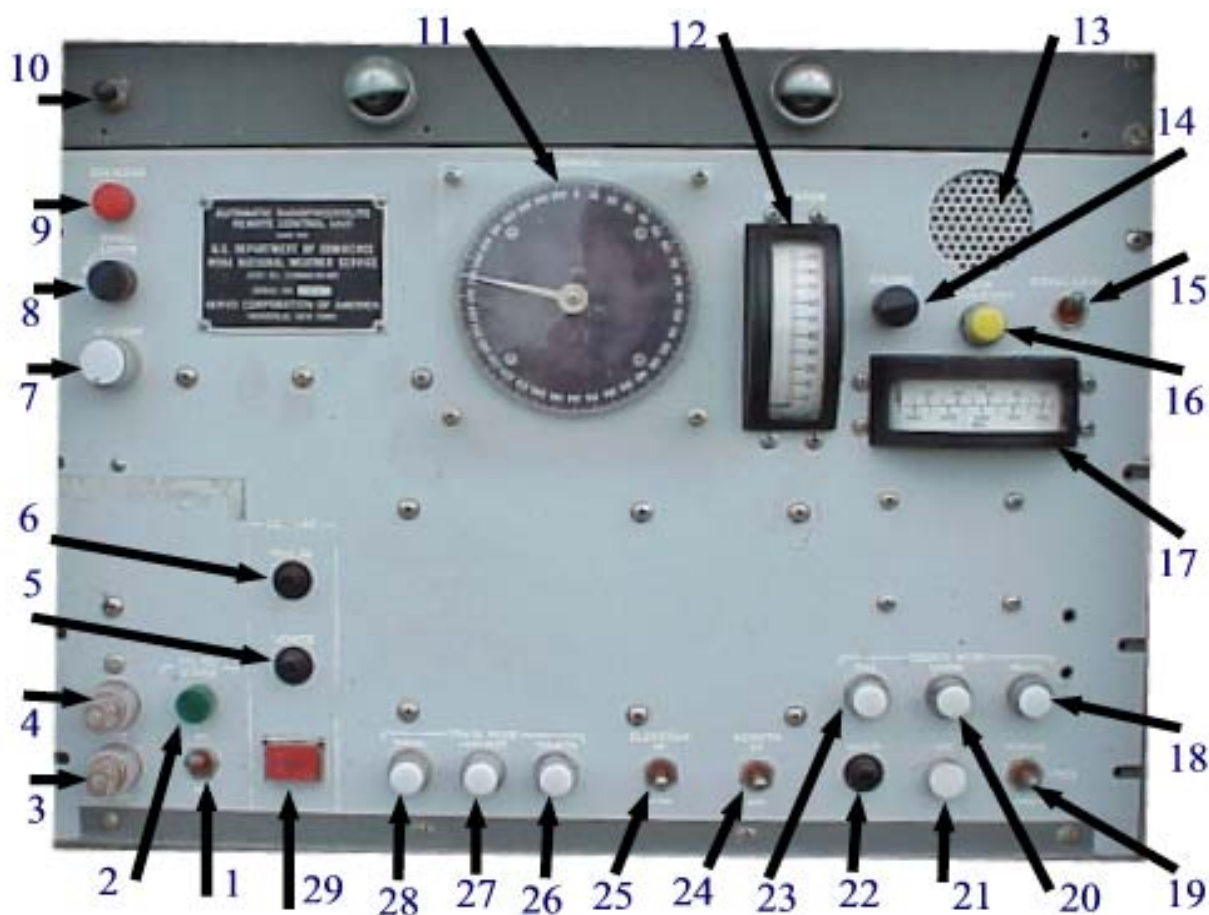


Figure B-11 - Open Remote Control Panel

Table B-3 - Remote Control Panel - Numbers corresponds to the respective controls in Figure B-11.

No.	Remote Panel - Controls	Function
1	ON/OFF Switch	Set to ON to activate the entire ART system.
2	Indicator	Green lamp is lit if remote ON/OFF is set ON and if In-Radome REC/ ANT control panel is set to ON.
3	0.5 AMP Fuseholder	If Fuse F1 is blown - Neon lamp is lit.
4	0.5 AMP Fuseholder	If Fuse F2 is blown - Neon lamp is lit.
5	RELEASE/REMOTE Switch	Press & hold to send a release signal to start the Elapsed Time display, Met Data Recorder, 60 seconds after button is pressed.



6	RELEASE/MANUAL Switch	Press & hold to send a release signal to start the Elapsed Time display, Met Data Recorder. In Simulator Mode, it also starts Simulator.
7	STANDBY Indicator Switch	When the MCU's STANDBY toggle button is pressed-in (white lamp), or either the ANT/REC, or RCU, STANDBY buttons are pressed, the Az and Elevation drives and Scan Motor are de-energized.
8	PANEL LIGHTS DIM Cntrl	Adjusts the illumination level of the front panel.
9	OVERLOAD Indicator	When there is an overload in the Az or El Drives the red lamp illuminates. Drives are de-energized.
10	Door Open Switch	Permits Front Panel lamps and RCU Panel Supply to be powered, if needed, when door is open.
11	AZIMUTH Indicator	Shows the azimuth angle (0 to 360) of the tracking dish. Measured in 1 degree increments.
12	ELEVATION Meter	Shows the elevation angle (-5 to +95) of tracking dish. Measured in 1 degree increments.
13	Loudspeaker	Gives audible repetition rate of incoming MET Data and release tones.
14	VOLUME Control	Adjusts the audio level of the loudspeaker.
15	SIGNAL LEVEL/FREQ Switch	Dual Indicator. When set to Signal level shows strength in dB. When set to Frequency, shows the frequency setting of the receiver in MHz.
16	LOW SENSITIVITY Indicator Switch	This is a push switch for Low/High sensitivity. A lit yellow lamp indicates Low sensitivity. An unlit lamp indicates, high.
17	Signal Level/Freq Meter	Dual purpose meter. Gives a scale for signal strength (0 to 110 dB), in 10 dB increments; and for frequency (1655 to 1705 MHz) in 5 MHz increments.
18	SEARCH MODE: MANUAL	Press-in (white lamp illuminates) to put into Manual Search Mode.
19	FREQUENCY INCREASE/DECREASE Switch	Usually is off. Hold in the INCREASE position to increase the receiver frequency, hold in the DECREASE position to decrease it.
20	SEARCH MODE: LIMITED	Press-in (white lamp illuminates) to put receiver into Limited Search Mode. {Seems to be toggle}

21	AFC Indicator	The white lamp is lit when system is locked-on to a received signal.
22	INITIATE Switch	Press-in this switch to enter Full Search Mode when the FULL Indicator Switch is lit.
23	FULL Indicator Switch	Press-in (white lamp) to enable receiver to be placed into Full Search Mode (see INITIATE switch).
24	AZIMUTH CW/CCW Switch	Usually is off. Hold in a CW position to move tracking dish in a clockwise direction. Hold in a CCW position to move dish in a counter-clockwise direction.
25	ELEVATION UP/DN Switch	Usually is off. Hold in the UP position to increase the dish's elevation angle. When held in a down position, will decrease the elevation angle. Can be used in all track modes.
26	TRACK MODE: FAR AUTO	Press-in (white lamp) to make system automatically and slowly track balloon.
27	TRACK MODE: NEAR AUTO Indicator Switch	Press-in (white lamp) to make system automatically and rapidly track balloon.
28	TRACK MODE: MANUAL Indicator Switch	Press-in (white lamp) to place system into manual track. With separate controls you need to input elevation and azimuth values with proper rates.
29	RELEASE / ABORT Switch	Press-in to cancel the remote release sequence. It will cancel the process started by the REMOTE/RELEASE switch.

3. NAVAID Network Stations: The NWS makes use of the LOnG RAnge Navigation (LORAN) system on an operational basis. The LORAN system consists of a coordinated network of four or five stations called a chain. Each chain transmits on a 100 KHz {carrier} a series of pulses, in a specific sequence. When all stations have transmitted, there is a final predetermined delay after which the master station again begins the cycle. The period of this multi-station transmission cycle is about 0.1 second.

Radiosondes are designed with an onboard tracker to receive and lock-on to each station in the chain. The tracker will observe the master station and at least two secondary stations, and then report the time at which each station is received in relation to the master station. Analogously, time segments can be converted to distance segments respectively from each station. At this point, the onboard processor computes the equivalent of a circular locus about each station, and then calculates the point where all three intersect. This point of intersection is the precise fix of the radiosonde. (As with RDF, the altitude of the radiosonde cannot be determined with this

tracking system).

Most NAVAID radiosondes transmit on a 403 MHz carrier and use the same modulation (e.g., Meteorological Data Oscillator) process as conventional radiosondes. When the radiosonde is within 7 miles the signal is received with an Omni directional antenna, and at the farther ranges with a Yagi (UHF) antenna. Operating instructions for NWS sites using LORAN tracking can be found in the VIZ WL9000 Operator's Manual.

It is important to note that observational data can be degraded and/or lost due to the following limitations associated with use of NAVigational AID (NAVAID) networks:

- a. Poor location of LORAN transmitters with respect to the release point (i.e., perspective of transmitter's forms a narrow angle or one transmitter located too close to release site).
  - b. Inadequate, or absence of a, telemetry repeater/relay between flight path and data processing station.
  - c. High electric fields induced by thunderstorms or snowfall (LORAN only) in the vicinity of radiosonde.
  - d. Radio interference, sometimes due to increased solar activity, especially for the 403 MHz band radiosondes.
  - e. Temporary loss of LORAN signal lock immediately following balloon launch.
  - f. Poor calibration of ground equipment.
4. Global Positioning System (GPS): The GPS consists of a global, integrated network of twenty-four global positioning satellites that operate on a frequency of 1575 MHz. Basic triangulation for wind determination requires reception from three GPS satellites. Positional data plus height calculation requires a minimum signal lock from four satellites. The high rate of microprocessor clock-speed applied to the triangulation equations makes possible the most precise location finding system available.

Requirements for reliable and interference-free upper air data in our increasingly RF-noisy, urbanized environment are expected to increase costs of conventional RDF and NAVAID operations. The NWS is currently developing a GPS tracking system. The system has been placed in the field and will continue into 2010.

4.1. Telemetry Receiving System (TRS): The TRS was designed and built by International Met Systems (InterMet) for the National Weather Service. The TRS receives meteorological Data transmitted over the 1680 MHz band from the radiosonde at a nominal 1 Hz rate and sends the received data to the Signal Processing System (SPS) via a 10.7 MHz signal. The SPS performs the required decoding of the received signal to recover the meteorological and GPS data measured by the sensors in the radiosonde. The SPS uses this data, together with GPS

data from a local receiver, to compute atmospheric pressure, temperature, humidity and wind at the radiosonde each second. The SPS sends the computed results to the workstation which controls the operation of the RRS and produces standardized weather data products. It operates with radiosondes and SPS and meets the TRS and SPS interface and data requirements.

The TRS works on the principle of an automatic Radiotheodolite. A two-meter parabolic dish antenna is mounted on a movable frame to allow for both azimuth and elevation movements. Movements are accomplished by servomotors under the control of the TRS Motion Control Unit (MCU). All electronic and mechanical elements required for acquiring the transmitted signal and maintaining the orientation of the antenna are contained in the antenna assembly.

Within the TRS 19" rack, are electronic components that provide power to the antenna, manage communications within the TRS, process the telemetry received by the antenna and transmit data to the Workstation. There are also components which provide control of the environment for those components within the 19" rack which cannot tolerate the extremes of the TRS environment.

Antenna functions can be controlled by the workstation or by the two Control Display Units (CDUs) included with the system.

4.1.1 Physical Description: The TRS consists of three units which are the antenna unit, workstation unit and launch area unit. Within the antenna unit, there are three major functional groups which are the RF group, yoke group and rack group.

Each of these groups consists of mechanical parts, electronic assemblies and cables.

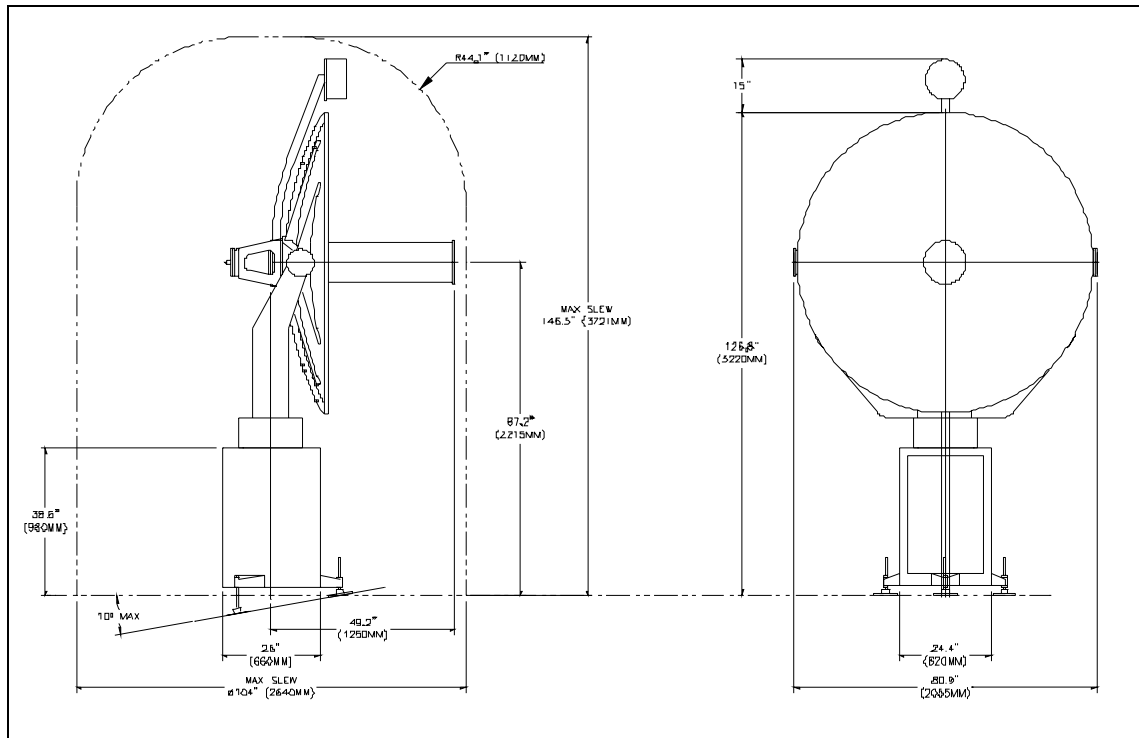


Figure B-12: TRS Installation Size

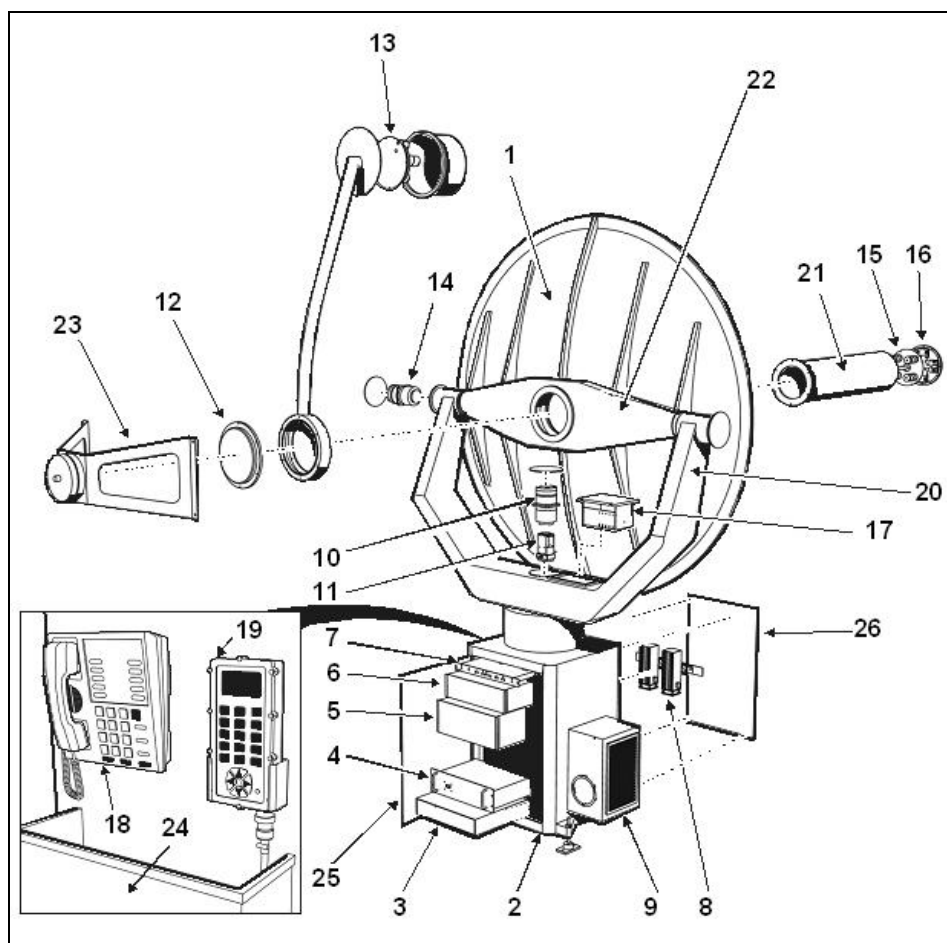


Figure B-13: Antenna Unit

Table B-4: Antenna Unit Assemblies

Figure B-13 IPB Item#	Description	ASN/Ref Des. (J700-)	Part Number
1	Main Dish		
	<b>RF Group</b>	1A1	
12	Receiver Assembly	1A1A1	J700-41068-10
15, 16, 21	Scanner Unit Assembly	1A1A2	J700-41067-10
16	Scanner Assembly	1A1A2A1	J700-41075-10
15	Helix Assembly	1A1A2A2	J700-41135-10
13	Wide Angle Gathering Sensor (WAGS)		
20	<b>Yoke Group</b>	1A2	
14	Elevation Motor Drive Assembly	1A2A1	J700-41142-10
10	Azimuth Motor Drive Assembly	1A2A2	J700-41142-10
17	Motion Control Unit	1A2A3	J700-41137-10

11	Slip ring Assembly	1A2A4	J700-41062-10
22	Cross member	1A2A5	J700-YYYY
2	<b>19" Rack Group</b>	1A3	
7	Systems Communication Assembly	1A3A3	J700-41072-10
6	Antenna DCE	1A3A4	J700-90015-1
8	Heater Assembly	1A3A6	J700-41801-10
5	Signal Processing System	1A3A7	N/A
4	Power Supply Assembly	1A3A8	J700-41803-10
3	Uninterruptible Power Supply	1A3A9	J700-90003-1
18	Local Area Intercom	1A3A10	J700-90007-1
19	CDU Assembly	1A3A11	J700-41074-10
9	Air Conditioner	1A3A12	J700-90002-1

The Uninterruptible Power Supply (UPS) is a standard 19-inch rack mount unit mounted in the 19" rack below the antenna. Refer to Table B-4 item 3. It provides the distribution backup AC line power to operate the entire TRS local and launch area components (except the Heaters and A/C) for at least 10 minutes of loss of installation power.

The heaters thermostatically control the environment within the 19 inch rack area to be greater than 0 degrees Celsius and less than 95% relative humidity (RH).

The A/C thermostatically controls the environment within the 19 inch rack area to be less than 40 degrees Celsius and less than 95% relative humidity (RH). The condensate hose, if used, is connected from the A/C and allowed to run out an air vent at the base of the radome.

#### 4.1.2 Major Components:

4.1.2.1 The Dish: The dish is a 2 meter diameter parabolic reflector with a 1 meter focal length and consists of two halves for ease of transportation to the sites. Each half is a sandwich construction containing an aluminum mesh grid sealed between two glass fiber layers. The concave surface of each half is protected with a gel coat. The two halves each have a vertical flange, which are bolted together at the time of installation. Each dish half has two vertical aluminum struts attached to it, which provide stiffening and the structure for mounting the dish to the cross-member. Refer to Figure B-13 item 1 page B-23.

4.1.2.2 The Receiver: The 1680MHz TRS receiver is contained in an aluminum housing mounted onto the rear of the member directly behind the scanner tube. All electrical connections to the receiver are made within the cross-member to protect cabling and connectors from the environment.

The synthesized receiver down-converts the received radiosondes signal from the 1680 MHz band to an Intermediate Frequency (IF) at 10.7 MHz. The receiver operates under microcontroller supervision and control.

4.1.2.3 Motor Drive Assemblies: The received radiosonde signal passes through several filters and down converted to the 10.7 MHz IF output frequency. It is the IF output signal modulated with the radiosonde data and the AM component modulated by the scanner. It is controlled by Automatic Frequency Control (ALC) to 13 dBm at 50 ohms. The synthesized receiver implements various tuning modes as well as (AFC) to ensure signal stability. The data channel's output level is maintained by the ALC system. A demodulated, base-band AM signal containing the tracking amplitude information is also extracted from the radiosonde signal.

The receiver operates under the control of a programmable microcontroller. A communications bus is provided for control of the receiver and access to the EEPROM. The EEPROM is used to store calibration data that permits field swapping of the receiver without further calibration adjustments to the station. The calibration includes data relating to frequency selection, signal strength, ALC control, AFC sensitivity and defaults. This data is set up in the factory. All communications are over this serial interface. The microcontroller is able to implement AFC, ALC and search tuning on the receiver. The receiver provides demodulated, base-band AM and FM signals for use in the Systems Communication Assembly (SCA). The AM signal is used to control antenna tracking.

4.1.2.4 Launch Area Box: The launch area box contains the Launch Area CDU with its cabling, and the Launch Area Intercom and Ringer. Refer to Figure B-14 item 1.

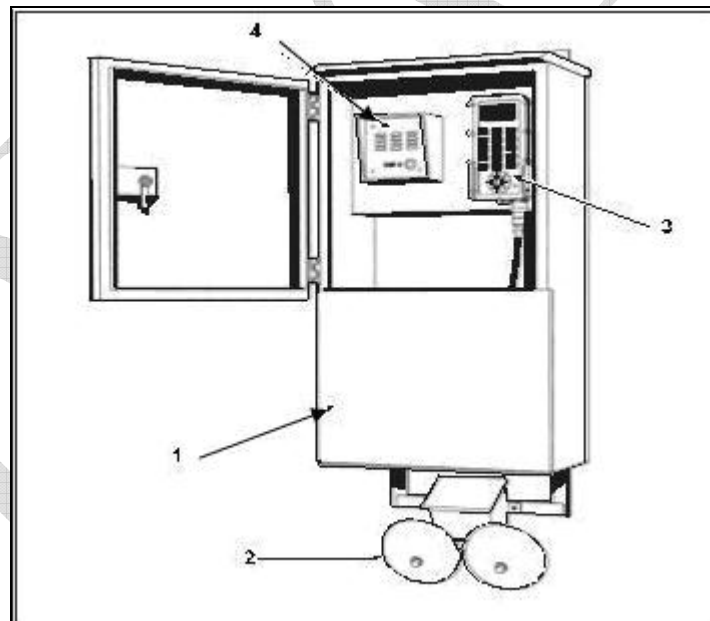


Figure B-14 – Launch Area Unit



Table B-5: Launch Area Unit Assemblies

<b>Table B-5</b>			
<b>IPB Item #</b>	<b>Description</b>	<b>Ref Des.</b>	<b>Part Number</b>
1	Launch Area Box	3A1	J700-41099-10
2	Launch Area Ringer	3A1A3	J700-90014-1
3	Launch Area CDU	3A1A1	J700-41074-10
4	Launch Area Intercom	3A1A2	J700-90008-1

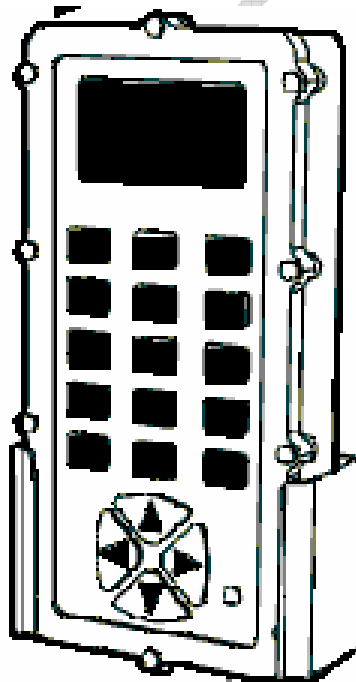


Figure B-15 - CDU

4.1.2.4.1 Launch Area Control Display Unit (CDU): The Launch Area Control Display Unit (CDU) is mounted in the Launch Area Box next to the Launch Area Intercom. Refer to Figure B-14 item 3. There is also a CDU located in the radome. This CDU is referred as the Local CDU. The two hand-held CDUs are identical. They incorporate a back-lit keyboard, beeper, back-lit liquid crystal display (LCD), CPU, RS-422 interface and power supply. The CDUs are used to facilitate local, direct control and monitoring of the operation of the antenna assembly. They implement a sub-set of the standard command set of the station, allowing them to execute various operations including slewing, tracking, target acquisition, receiver control, reference set-ups, data and status polling and launching of built-in-tests. They provide the audio

output of the sonde modulation or the receiver tuning aid. Information on how to use the CDUs is contained in Section 4.4.2 page B-31..

The local CDU can be used to override ("lock-out") commands from the launch area CDU and the workstation. This gives a technician working at the antenna site the ability to control the antenna assembly and prevent unexpected movement caused from commands given by the other CDU or the workstation.

The CDU Processor Board is the standard TRS processor block including microcontroller, RAM, ROM and interfaces. It processes commands and data, requests receiver operations and antenna movements.

The CDU com port is a digital data channel carrying communications between the CDU and the TRS antenna assembly. The CDU com port is a full-duplex RS-422 asynchronous serial channel at 19,200 baud with 8 data bits, 1 stop bit and no parity. The FM baseband signal contains the radiosonde modulation data. It is an audio frequency radiosonde modulation signal. The system power provides all power for the functions of the CDU (nominally +24 vdc.). The system power is converted to voltages suitable for use by the CDU.

There is one cable plugged into the CDU: The Launch Area CDU Cable connects the Launch Area CDU Extension Cable to the CDU.

4.1.2.4.2 Launch Area Intercom: The Launch Area Intercom is a rugged speakerphone which provides hands free operation. Refer to Figure B-14 item 4 page B-25. There are two cables plugged into the Launch Area Intercom:

- a. The Launch Area Intercom Cable connects the Bulkhead to the Launch Area Intercom.
- b. The Launch Area Ringer Cable connects the Launch Area Ringer to the Launch Area Intercom.

4.1.2.4.3 Launch Area Ringer: The launch area ringer provides a loud ring when there is an incoming call from the workstation. Refer to Figure B-14 item 2 page B-25. There is one cable plugged into the Launch Area Ringer. The Launch Area Ringer Cable connects the Launch Area Intercom to the Launch Area Ringer.

4.2 Overall System Description: The TRS works on the principle of an automatic Radiotheodolite. A two-meter parabolic dish is mounted on a movable frame that allows for independent azimuth and elevation movements. A scanning antenna mounted at the end of the bore sight tube receives and samples the incoming RF signal by electronically switching between four helical elements.

The antenna measures relative signal strength between the four elements to generate azimuth and elevation error values relative to bore sight. The motion control unit commands the azimuth and elevation servomotors to move the antenna as necessary to minimize the error signals. This allows the antenna to track a radiosonde transmitting at low power on the 1680 MHz band.

Along with PTU, a TRS compatible radiosonde transmits GPS coordinates. These coordinates are received by the TRS and passed on to the SPS where differential correction is applied. This information is then passed via the Digital Communication Equipment (DCE) to the Workstation where wind speed and direction are calculated.

The TRS Radiotheodolite uses GPS technology for wind finding and RDF technology for tracking. The antenna uses the azimuth and elevation errors to maintain maximum contact with the radiosonde transmitter but not to derive wind speed and direction. By combining the two methodologies, TRS seeks to achieve the highest possible range and accuracy of signal reception.

#### 4.3 Overall System Operation:

4.3.1 Automatic Operation: As an automatic Radiotheodolite, the TRS is intended to operate with no user intervention once the radiosonde signal is acquired and locked on. In situations where the signal is lost, the system includes two search patterns that can be activated by the operator to try to locate the radiosonde signal and return to automatic tracking mode.

The operator prepares a radiosonde and balloon in accordance with their published procedures. The TRS is powered on and automatically executes its initialization. Once complete, the TRS receiver is tuned to the radiosonde. Via the Workstation, the operator executes the pre-flight procedures. Once complete, the radiosonde is carried to the balloon where it is attached via the flight train. Walking the balloon and radiosonde from the inflation building to the launch area, the operator uses the Launch Area Control Display Unit (CDU) to put the TRS into the automatic tracking mode. Since the radiosonde is close to the TRS, the tracking is accomplished using the Wide Angle Gathering Sensor (WAGS). In this mode, the TRS will track the radiosonde through the higher dynamics of the launch. Shortly after launch when the dynamics of the balloon have diminished, the tracking transfers from the WAGS to the Narrow Angle Gathering Sensor (NAGS). This tracking mode is used for the remainder of the flight.

**Note:** The beam width of WAGS is 100 degrees and the beam width of NAGS is 15 degrees. These values are important to remember to ensure the receiver has not initially locked onto a side lobe.

4.3.2 Manual Operation: The TRS can be operated in manual mode by entering slew commands via the CDU or workstation, or by entering numeric azimuth and elevation coordinates. Basic user options include the following:

- a. Automatic frequency control on/off.

- b. Manual frequency set.
- c. Automatic frequency search.
- d. Automatic level control on/off.
- e. Automatic tracking on/off.
- f. Relative position set.
- g. Absolute position set.
- h. Limited search.
- i. Full search.

All of the available operating modes and procedures are described in Section 4.4.2.

4.4 Tracking: Automatic tracking of the line-of-sight (LOS) to a radiosonde is provided by the Scanner, Receiver, Motion Control Unit (MCU) and Motor Assemblies all working together.

The TRS continuously tracks a radiosonde from launch until termination of the flight as the radiosonde is carried up through the atmosphere by an aerological sounding balloon. The TRS is designed to be operated by a Control Display Unit (CDU), or by commands from a workstation.

There are three sources of control for the TRS. They are the Local Area CDU, the Launch Area CDU and the government provided Workstation. The two CDUs are mechanically and electrically identical. The functional differences are learned by the CDU from its connection to the TRS, i.e., the TRS tells the CDU how to behave. The Launch Area CDU is located in the Launch Area Box but because of its long cable, can be operated by as much as 50 feet away from the Launch Area Box. The Local Area CDU is located in the radome but because of its cable length, can be operated from anywhere within the radome or just outside of the radome door. Both locations provide a mounting bracket for the CDU and excess cable storage. This is especially important for the Launch Area CDU to protect it from weather and the damaging effect of radiation from the sun.

The operating procedures contained in this appendix cover commands initiated by either of the two CDUs. It also contains procedures for the climate control of the equipments within the 19" rack, and the power and communications control of the entire system. Operation of the TRS by the workstation is not part of this manual. Also, the radiosonde flight preparation and flight procedures are not part of this manual.

4.4.1 Control Display Unit: Each CDU is housed in a light-weight rectangular metal casing. The width of the casing is such that it is easily held in one hand. An LCD is mounted in the upper section of the face of the casing. Each CDU incorporates a keypad on the lower section of the face of the casing for numeric and functional operations plus a set of direction controls for slew/level control. Each CDU has an interface cable which is connected between the base of the CDU and the Systems Communication Assembly (SCA).

The display is a 120 x 64 pixel graphics LCD module. The LCD includes backlighting, and has an extended temperature operating range. The backlighting is permanently enabled. The keypad consists of 15 keys, arranged in a 3x5 matrix and 4 direction control keys, as shown in a graphic

representation in Figure B-16. The keys are made of molded silicon and have a full tactile feel and a travel of approximately 1-2mm. A short, fixed-volume beep accompanies each key press (or key repeat).

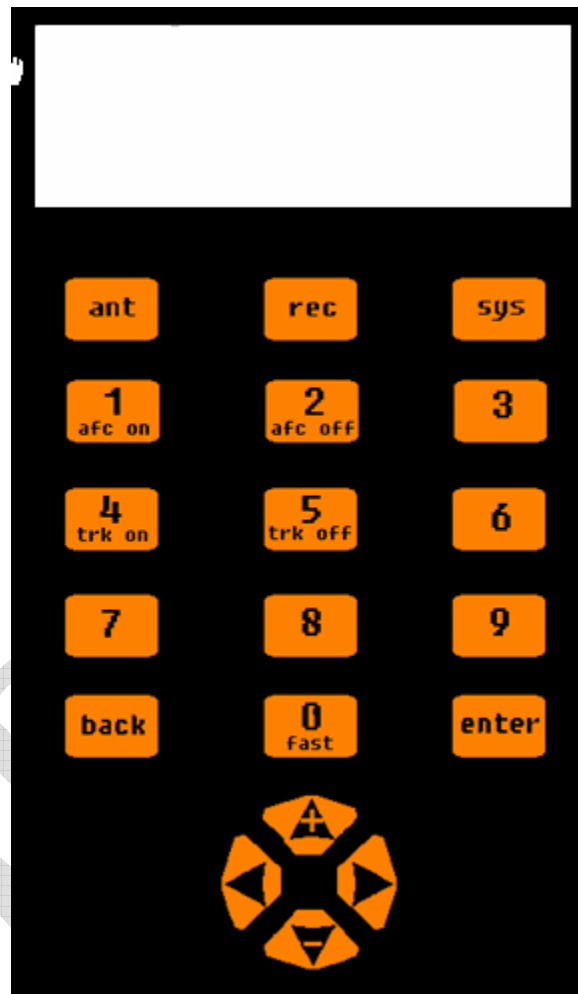


Figure B-16 – CDU Keyboard

**4.4.2 User Interface:** Control of the station and CDU is achieved via an interface that implements quick, logical steps to guide the user to the desired result. Often, used functions are available with a minimal of key strokes and screen changes. Feedback to user input is apparent, positive and effectively instantaneous.

Space constraints on the keyboard dictate that functions be accessible by a menu selection system. Often-used functions are implemented to require a minimum number of keystrokes before they are executed. There is a main or default display mode called the Idle State and three

functional menu driven modes relating to the Antenna or “Ant” functions, the Receiver or “Rec” functions and the System of “Sys” functions. Intermediate or error screens indicate time delays or response failures from the system.

### Idle State Overview

The Idle State is the most used mode and functions available from it require the fewest keystrokes.

### Idle State

Under routine conditions, the CDU is in the Idle State. In this state, the screen gives an upper level set of data on the station operation. It is displayed and updated at a suitable rate such that the observer has fresh, flicker-less data required for the situation. The data screen that is displayed in this state may also be selected via the SYS key and the Data sub-menu.

After initialization, the CDU begins operation in the idle state. Some data entry requires selection of menus, perhaps submenus, and entry of numeric data to complete an operator instituted action. If the operator has stopped pressing keys before finishing the key-stroke action, and approximately 60 seconds elapses with no keys being selected, the non-completed key-strokes or operations are cancelled and the CDU reverts to the Idle State.

### Menus

Numeric-selection menus are used to guide the user in their choice at a particular state. Selection of an item is achieved by pressing the appropriate numeric key. The Back key is used to revert to the menu level or state prior to the one currently displayed.

### Keyboard

Some of the numeric keys are used for quick access to often-used functions. These functions are available when the CDU is not expecting a numeric input. The functions are AFC On/Off and Tracking On/Off.

The numeric keys are used to select numbered menu items, or to enter numeric data. A fixed decimal place position is indicated in entry fields for floating-point numbers. The Back key is used to delete individual numbers entered in a numeric entry screen. If a menu is displayed, this key is used to revert to the menu level state above the one currently displayed.

The 3 menu keys across the top row, if pressed, cause the CDU and station to abort the current operation menu or state and display the applicable top-level menu for the particular menu key pressed.

### Direction Controls

The direction control keys, in combination with the “0/fast” key, slew the antenna when the CDU is in the Idle State. The speed of slewing is dependent on the length of time the key(s) are

held down. Table B-6 details the operation of the direction control keys.

Table B-6: Direction Controls

INITIAL SLEWING SPEED	ACTION	FINAL SLEWING SPEED
Antenna stationary	Direction control pressed without “0/fast”	1° / second
Antenna stationary	Direction control pressed without “0/fast”	10° / second
1° / second	Direction control held for > 4 seconds	5° / second
1° / second	“0/ fast” key pressed	10° / second
5° / second	“0/ fast” key pressed	20° / second
5° / second	Direction control released and repressed	1° / second
10° / second	Direction control held for > 4 seconds	20° / second
10° / second	“0/ fast” key released	1° / second
20° / second	Direction control released and repressed	10° / second
20° / second	“0/ fast” key released	5° / second

Elevation and azimuth slewing movements may be obtained simultaneously by pressing both vertical and horizontal direction keys. Should the station be operating in auto-tracking mode when a direction control key is pressed, the station is taken out of the auto-tracking mode and set to manual mode if that key is pressed for at least ½ second. The observer must remember to press the “Track on” key to resume auto-tracking after manually slewing the dish.

Antenna slewing via the direction keys is not active in non-Idle State screens.

The Up (+) and Down (-) direction control keys are also used in the following situations:

- a. Manual tuning the four available tuning speeds, using the analogy of tuning speed versus angular rotation speeds, are 10 kHz, 100 kHz, 500 kHz and 1 MHz per second.
- b. Volume level - under the SYS menu
- c. LCD contrast adjustment - under the SYS menu.
- d. To add a “+” or “-” to the front of signed numeric data entries.

Antenna Menu Key: Pressing the “ANT” key causes the CDU to display a menu of operations related to the control and positioning of the antenna. Options 2, 3 and 4 are not displayed when the station is operating in the Auto Tracking Mode.



ANTENNA CONTROL	
1. Position	4. Auto
2. To Zero	5. Manual
3. Search	6. Calib

Antenna Positioning: When option 1 is pressed, the CDU displays a level 2 menu screen. In this condition, the user is asked whether the desired movement is to be to an absolute position, or if a relative movement is desired.

ANTENNA POSITIONING
1. Absolute
2. Relative

Selection of option 1 causes the CDU to display the following screen:

ABSOLUTE POSITIONING
1. Azimuth
2. Elevation

Selection of option 1 or 2 causes the CDU to display a numerical data entry screen. The screen for option 1 is shown below:

ABSOLUTE POSITIONING
Azimuth
+000.00°

Numerical entry is now permitted. Numbers are entered at the right hand position, and scroll towards the left. The sign of the entry can be altered using the direction control keys (Up = '+',

Down = '-'). The Back key deletes the last number entered, and scrolls all other numbers one position to the right. Pressing back when the display shows 000.00 returns the CDU to the previous screen. The ENTER key terminates the operation. On pressing ENTER, the station implements the desired movement in the selected axis, and the CDU returns to the Idle State. Range checking is initiated checking for Azimuth entries outside -360.00 to +360.00 and Elevation entries outside -10.00 to +91.50. Entries outside of these ranges produce an audible and visual warning. The user may then modify the value.

<p><b>ABSOLUTE POSITIONING</b></p> <p><b>Elevation</b> <b>-012.49 °</b></p> <p><b>ERROR: Illegal Entry</b></p>
--

If option 2 (Relative Positioning) is selected in the level 2 menu screen above, the CDU displays the following level 2 menu screen:

<p><b>RELATIVE POSITIONING</b></p> <p><b>1. Azimuth</b> <b>2. Elevation</b></p>
---

Selection of option 1 or 2 causes the CDU to display a numerical data entry screen. The operation proceeds as previously detailed.

The maximum relative movement in the Azimuth axis is  $\pm 180.00^\circ$ . The maximum relative movement in the Elevation axis is  $\pm 101.50^\circ$ .

Zero Position: When option 2 is pressed, the CDU displays the following level 2 menu screen:

**RELATIVE POSITIONING**

- 1. Azimuth**
- 2. Elevation**
- 3. Both Axis**

Selection of an option causes the station to slew the selected antenna axis or axes to the 0.00° position and the CDU returns to the Idle State.

Antenna (Limited) Search: When option 3 is pressed, the CDU starts with requests for further data entry before a limited search is begun. Limited search moves the antenna in azimuth and elevation over a limited range of angles attempting to find the direction to point to maximize the signal received from the radiosonde. A numerical data entry screen is displayed for entry of the expected signal strength of the radiosonde when it is located. The value entered here is stored for recall as the initial value for this entry the next time that a search is requested.

**ANTENNA SEARCH**

**Find a signal above  
-065 dbm**

The next screen is used to enter the cone angle of the search. This is the maximum angle that is to be described by the limited search. The value entered here is stored for recall as the initial value for this entry the next time that a search is requested.

**ANTENNA SEARCH**

**Maximum cone angle  
10°**

After entry of the maximum cone angle, the CDU instructs the station to commence a limited search, centered on the current elevation and azimuth angles with signal strength and cone search

angle as selected. The CDU then reverts to the Idle State, displaying the General Data screen.

After entry of the maximum cone angle, the CDU instructs the station to commence a limited search, centered on the current elevation and azimuth angles with signal strength and cone search angle as selected. The CDU then reverts to the Idle State, displaying the General Data screen.

Auto Tracking: When option 4 is pressed, the station enters the Auto Tracking Mode. In the Auto Tracking Mode, the system controls the antenna movement and positioning to maintain it's alignment with the radiosonde. A tick is displayed alongside this menu option if the station is already in the Auto Tracking Mode. The CDU reverts to the Idle State after selecting this option.

Manual Tracking: When option 5 is pressed, the station enters the Manual Tracking Mode. In this mode, the antenna remains stationary unless moved by a command received from a CDU or the workstation. A tick is displayed alongside this menu option if the station is already in the Manual Tracking Mode. The CDU reverts to the Idle State after selecting this option.

Calibration: When option 6 is pressed, the CDU progresses through a number of screens, sending instructions to the station and telling the user steps to take and being taken for tracking calibration of the station.

The first screen shown is as follows:

### **TRACKING CALIBRATION**

**Please prepare the test  
signal source**

**ENTER to proceed**

After the user presses ENTER, the CDU sends instructions to the station to perform the following operations:

- a. Move the antenna to point to the pre-configured location of the test signal.
- b. Tune to the test signal.
- c. Enable receiver AFC.
- d. Enable auto-tracking.
- e. Sample antenna angular data for approximately 25 seconds.
- f. Evaluate tracking performance by determining average antenna angles and standard deviations.
- g. Store electrical bore sight offsets if the results are judged to be acceptable.

The CDU displays a bar graph showing the progress of the calibration operation. The entire operation aborts with an appropriate message should problems be encountered.

The CDU reverts to the Idle State after completion of the calibration.

Receiver Menu Key: Pressing the “REC” key causes the CDU to display a menu of operations related to the control of the receiver as follows:

<b>RECEIVER CONTROL</b>	
<b>1: Auto</b>	<b>4: Tune</b>
<b>2: Manual</b>	<b>5: Go Freq</b>
<b>3: Search</b>	

Automatic Frequency Control (AFC) On: When option 1 is pressed, the station receiver enters the Automatic Frequency Control Mode. With AFC on, the receiver controls its frequency to track the frequency of the radiosonde. A tick is displayed alongside this menu option if the receiver is already exercising AFC. The CDU reverts to the Idle State after selecting this option.

Manual Frequency Control Off: When option 2 is pressed, the station receiver enters the Manual Frequency Control Mode (no AFC). With AFC off, the receiver frequency is not varied, except following appropriate instructions from the CDU or workstation. A tick is displayed alongside this menu option if the receiver is in Manual Frequency Control mode. The CDU reverts to the Idle State after selecting this option.

Receiver Search (Automatic Signal Location): Selecting option 3 causes the CDU to display a series of numerical data entry screens, after which search for the frequency of the radiosonde is launched. The first screen permits entry of the starting (lower) frequency of the search. The value entered here is stored for recall as the initial value for this entry screen the next time that a frequency search is requested.

<b>RECEIVER SEARCH</b>
<b>Lower Frequency</b>
<b>1680.40 MHZ</b>

Numeric entry is detailed in Receiver Control above. Range checking is implemented when ENTER is pressed. (The CDU shows a brief error message and aborts the operation if an illegal value is entered.)

The second screen permits entry of the ending (upper) frequency of the frequency search. As stated, the value entered here is stored for recall as the initial value for this entry screen the next time that a search is requested.

<p><b>RECEIVER SEARCH</b></p> <p><b>Upper Frequency</b></p> <p><b>1700.00 MHZ</b></p>
---

After entry of the Upper Frequency, the CDU displays the search screen, the receiver AFC is turned off, and the receiver is instructed to begin the frequency search operation. The screen indicates the current frequency and signal strength numerically and graphically.

<p><b>Freq:1684.23MHz Srch</b></p> <p><b>F:</b> [REDACTED]</p> <p><b>SIG:-75dBm</b></p> <p><b>S:</b> [REDACTED]</p>
---

Pressing the ENTER or Back keys during a search ends the search and causes the receiver to hold the last frequency. If ENTER is pressed, the CDU reverts to the Idle State. If Back is pressed, the CDU reverts to the previous screen.

ENTER should be pressed if/when a suitable signal has been located to restore the CDU to the Idle State.

Tune (Manual Tuning): Pressing option 4 takes the CDU to the Manual Tuning screen. The user may now manually change the receiver frequency, using the Up and Down direction control keys. Tuning is carried out in steps of 10 kHz, 100 kHz, 500 kHz or 1MHz. The receiver AFC may be turned off or on using the “1/AFC Off” and “2/AFC On” keys.

<p><b>Freq:1684.23 MHz Man</b></p> <p><b>F:</b> [REDACTED]</p> <p><b>SIG:-98dBm AFC Off</b></p> <p><b>S:</b> [REDACTED]</p>
---

Pressing ENTER takes the CDU back to the Idle State. Pressing Del/Back takes the CDU back to the previous screen.

Go to Frequency: Selecting option 5 causes the CDU to display a numerical data entry screen, which permits entry of the frequency desired to tune the receiver.

<p align="center"><b>RECEIVER TUNING</b></p> <p align="center"><b>Go To Frequency</b></p> <p align="center"><b>1680.00 MHz</b></p>
--

Numeric entry is as detailed in Receiver Control. Range checking is implemented over the range 1668.40MHz to 1700.00MHz. When ENTER is pressed, AFC is turned off (if it was on), the receiver frequency is changed and the CDU reverts to the Idle State.

System Menu Key: Pressing of the “SYS” key causes the CDU to display a menu of options to specify the operation and configuration of the CDU.

<b>CDU CONTROL MENU</b>	
<b>1: Data</b>	<b>4: Volume</b>
<b>2: LCD</b>	<b>5: Master</b>
<b>3: Audio</b>	<b>6: Version</b>

Data: When option 1 is pressed, the CDU displays a level 2 menu screen as follows:

<p align="center"><b>DATA DISPLAY</b></p> <p align="center"><b>1: General</b></p> <p align="center"><b>2: STATUS</b></p> <p align="center"><b>3: Position</b></p>
---

General Display: When option 1 is pressed, the CDU reverts to the Idle State, and displays the General data screen. The General data screen reports antenna angles, tracking errors, receiver frequency, signal strength, and antenna and receiver status indicators (e.g., Man, Track, Search,



AFC, Scan, Squelch) as follows:

<b>Az: 284.57°</b>	<b>Err:026&gt;</b>
<b>El: 007.29°</b>	<b>Err: 018^</b>
<b>F :1678.34</b>	<b>SIG: -102</b>
<b>Ant: Man</b>	<b>Rx: AFC</b>

Status Display: When option 2 is pressed, the CDU reverts to the Idle State and displays the Status data screen whenever it is in this state. The Status data screen reports LRU POST Status, SCA Input voltage and current as follows:

**SYSTEM STATUS**

**Faults: None**

**VOLTAGE: 23.6V**

**Current: 4.7A**

Position Display: When option 3 is pressed, the CDU reverts to the Idle State and displays the Position data screen whenever it is in this state.

**STATION LOCATION**

**Lat : 032°18'37.8"S Long:**

**018°44'07.2"E**

**ALT : 356M**

LCD Contrast: When option 2 is pressed, the CDU displays a screen which the user uses to adjust the contrast of the LCD display as follows:

**LCD CONTRAST ADJUST****C:** **+: Increase****- : DECREASE**

Pressing ENTER takes the CDU back to the Idle State.

Audio Outputs: When option 3 is pressed, the CDU displays a level 2 menu screen. From this menu the user selects which audio channels will be output.

**AUDIO OUTPUTS****1:Tuning Aid****2: FM**

Note that the CDU either outputs a “Tuning Aid” or the received FM signal. The currently selected output will have a 'tick' next to it.

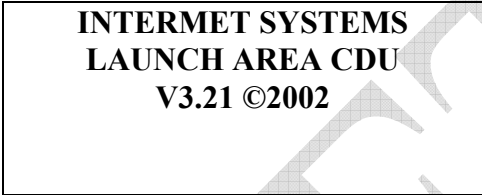
Volume Level: When option 4 is pressed, the CDU displays a screen which the user uses to adjust the volume of the audio output as follows:

**VOLUME CONTROL****V:** **+ : Increase****- : DECREASE**

A continuous sample tone is generated during this operation. Pressing ENTER takes the CDU back to the Idle State.

Master Control: (This option will only be displayed and available for selection if the CDU being used is the Local CDU). When option 5 is pressed, the station toggles Local CDU Master Control on or off. The CDU reverts to the Idle State after selecting this option. When the station is in Master Control mode, only the Local CDU may control antenna movements.

Version Information: When option 6 is pressed (option 5 if Master Control is not available), the CDU displays the manufacturer, the CDU location (type), the firmware version information and a copyright notice.



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LAUNCH AREA CDU  
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Pressing ENTER takes the CDU back to the Idle State.

Intermediate and Error Screens: Should a requested operation require a command to be sent to the tracking station, the CDU displays the following screen:



**Waiting for response  
From system...**

Should the system not respond as expected, error screens are displayed. If no response is obtained, the following screen is displayed:



**\*\*\* ERROR \*\*\*  
System does not  
Respond!**

If a requested operation resulted in an error response, it is displayed as follows:

<p><b>*** ERROR ***</b>  <b>Error #xx</b>  <b>Descriptive Message</b></p>
---

The error message text will be one of those shown in Table B-7.

TABLE B-7 – CDU Error Messages

Error Number	Descriptive Message	Reason
00	Bad Checksum	Unlikely to occur. May be a result of noise.
01	Bad Numerical Value	Unlikely to occur. May be a result of noise.
02	AFC On	Attempt to manually tune receiver while AFC is enabled.
03	Auto Tracking On	Attempt to move antenna while automatic tracking is enabled.
04	Destination Unknown	Unlikely to occur. May be a result of noise.
05	Invalid Operation	Attempt to change to an unobtainable antenna position or receiver frequency (e.g., in relative movements).
06	Operation Locked Out	Local CDU has locked out this operation.
07	Internal Comms Error	Unlikely to occur except if internal LRUs are faulty.
08	BIT In Progress	System busy with off-line tests. Operation is unavailable at this time.
09	Unknown command	Unlikely to occur. May be a result of noise.
10	Command Format	Unlikely to occur. May be a result of noise.
12	Busy Initializing	System is busy with initialization.
13	Busy Warming Up	System is busy with warm up

		operations.
Error Number	Descriptive Message	Reason
14	Busy Calibrating	System is busy with tracking offset calibration.
60	Busy Moving	Antenna movement is currently in progress. Re-attempt the command once movement has ceased.
61	Motor Fault	Control of this motor is not available. Refer to POST results.
62	Motor over-current	Motor is experiencing an over-current. Investigate and rectify the situation.
63	Search in Progress	Antenna movement is not permitted while a search is in progress

4.5 Climate Control: The Rack Group contains Commercial Off-The-Shelf (COTS) hardware which is not suited for the environment required for the entire antenna. These COTS systems are the Antenna DCE, +24 VDC power supply module within the Power Supply Assembly, the Uninterruptible Power Supply (UPS) and the Local Area Intercom. These units are placed in (or on, in the case of the Local Area Intercom) the 19" rack to protect them from the temperature and humidity extremes. The climate control for the 19" rack consists of the Heaters and the Air Conditioner.

4.5.1 Environment: The climate control equipment is designed to reduce the extremes of temperature and humidity from the required -51°C to +50°C and 0% to 100% relative humidity dome ambient to 0°C to +40°C and 0% to 95% relative humidity. The thermostats for the Heaters and Air Conditioner are set at the factory to 40°F (4.4°C) for the Heaters and 35°C (95°F) for the Air Conditioner.

4.5.2 Circulation Fans: There are two fans within the Air Conditioner. The circulation fan runs whenever power is applied. This is the main air circulation within the Rack Group. The compressor fan only runs when the thermostat demands cooling. There is a fan for each of the Heaters. They run only when their thermostat demands heating.

4.6 Power Supply: Power must be applied to the antenna at all times. Even while in the standby condition, power must be applied to several functions at all times. These are the UPS for battery charge maintenance, the Antenna DCE for communications and, of course, the environmental control of the Air Conditioner and Heaters. Power to the antenna and receiver is applied by turn-on of the UPS.

If power cannot be applied to the Climate Control Equipment, all systems must be kept in their non-powered state until the ambient temperature and humidity within the Rack Group has

returned to within the required values described in Section 4.5.1 page B-44.

The antenna can be switched from its standby condition to fully operational by two different methods depending on the location of the operator. Figure B-17 page B-44 shows a block diagram of the power control for the TRS.

The operation is as follows:

- a. AC power is applied through the circuit breaker within the Power Supply Assembly LRU.
- b. With the circuit breaker on, dome AC power is applied to the Heaters, the Air Conditioner, the UPS and the Antenna DCE.
- c. To power the entire antenna, push the On/Off button on the face of the UPS if inside the dome or send the proper command to the UPS from the Workstation if inside the Workstation Unit area.
- d. Conditioned/protected power is then applied to the Antenna DCE, the SPS and the +24 VDC power supply module within the Power Supply Assembly LRU. This then also applies the +24 VDC to the remainder of the antenna assembly.
- e. The UPS then provides for at least 10 minutes of power for a flight upon loss of the dome AC power.
- f. Shut down the antenna functions after a flight by pushing the On/Off button on the face of the UPS if inside the dome or send the proper command to the UPS from the Workstation if inside the Workstation Unit area.

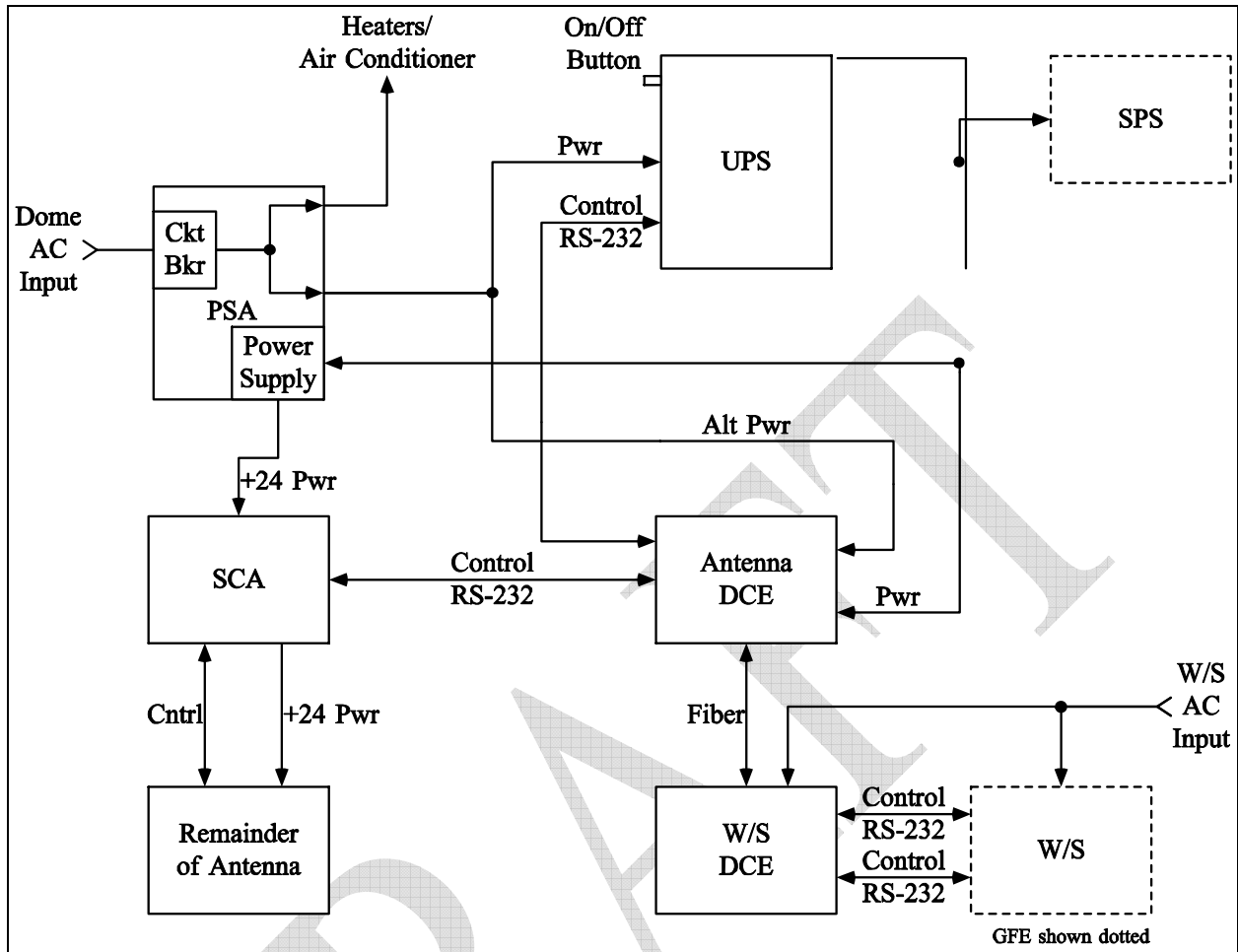


Figure B-17 – Diagram of TRS Power Control

4.7 Communications: All digital communications between the dome and the Workstation; voice from the Launch Area CDU and/or the Local Area CDU to the Workstation are provided by the Antenna DCE and the Workstation DCE working together. These communications are monitored and controlled by the Workstation.

There are two digital communications ports required for the complete operation of the TRS. There is one digital port required for the operation of the SPS. This leaves three spare ports available for other systems. The spares must be configured and controlled through the Workstation for other systems are required. The default configuration of the six ports are shown in Table B-8 page B-47. Status monitoring and control are provided by the Workstation.



CHANNEL:	1:1	1:2	2:1	2:2	3:1	3:2
PARAMATER	VALUE	VALUE	VALUE	VALUE	VALUE	VALUE
SPEED	19.2 KBPS <sup>1</sup>	19.2 KBPS <sup>1</sup>	2.4 KBPS <sup>1</sup>	9.6 KBPS <sup>1</sup>	9.6 KBPS <sup>1</sup>	9.6 KBPS <sup>1</sup>
PROTOCOL	ASYNC	ASYNC	ASYNC	ASYNC	ASYNC	ASYNC
ASYNC_ DATA	8BITS	8BITS	8BITS	8BITS	8BITS	8BITS
TIMING	DCE	DCE	DCE	DCE	DCE	DCE
CTRL_SIG	LOCAL	LOCAL	LOCAL	LOCAL	LOCAL	LOCAL
CTS	=RTS	=RTS	=RTS	=RTS	=RTS	=RTS
RTS_CTS_DEL	MIN	MIN	MIN	MIN	MIN	MIN
V.54_ EMUL	DCE-DCE	DCE-DCE	DCE-DCE	DCE-DCE	DCE-DCE	DCE-DCE
DSR_ MODE	ON	ON	ON	ON	ON	

Table B-8: Configuration Data from the DCE IDD

**Note:** Serial ports 1:1 and 1:2 are used by the antenna/receiver status monitoring and control and Signal Processing System (SPS) channels respectively. They are required to operate at the listed 19.2 KBPS. Serial port 2:1 is used by the UPS to control the state of its output voltages to ON or OFF. Serial ports 2:2 through 3:2 are spares for future RS-232 asynchronous port usage expansion including surface observing instruments. They are set by default to 9.6 KBPS. The baud rate for a spare channel to be used must be changed to that required by the specific expansion port interfaces. The ranges of standard baud rates available for the spare channels are from 300 to 38,400 baud.

## APPENDIX C - BALLOON FAMILIARIZATION

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1. Introduction: The success of the radiosonde observation depends upon the performance of the lighter than air gas filled balloon. The balloon lifts the radiosonde at a predetermined rate of ascent through the troposphere and stratosphere for periods typically lasting from 90 to 120 minutes.

2. NWS Balloon Types: Radiosonde balloons are spherically shaped films of natural latex or synthetic rubber (e.g., neoprene) which, when inflated with helium or hydrogen gas are used to transport the radiosonde flight train into the upper atmosphere. The skin of these balloons is extremely thin, except at the neck. When inflated, the wall of the balloon ranges in thickness from 0.051 to 0.102 mm at sea level to 0.0025 mm at typical bursting altitudes of 30 km or higher. Additionally, the balloon expands in size from an approximate release diameter of 1.85 m to an expanded diameter of 7.4 to 9.8 m at burst altitude. Considering these dimensions, it is obvious that the smallest cut, bruise, abrasion, scratch, or undue strain the balloon may sustain during pre-flight preparations is likely to cause the balloon to burst prematurely at a lower altitude than it routinely attains.

2.1 Routine Upper-Air Soundings: The NWS routinely uses general purpose balloons rated to achieve burst heights of either 26 kilometer or 30 kilometers. These balloons are used under average weather conditions when winds are relatively light and there is little threat of moderate

or greater icing conditions. These balloons are thin skinned and are light weight to reduce the required volume of inflation gas needed to maintain proper ascension rates. See Figure C-1 showing a general purpose balloon with the train attached inside the inflation building prior to release.

Ascent rates should average between 275 - 350 meters per minute throughout the flight. Observations with ascent rates of 250 meters per minute or less may be the result of under-inflation or possibly a leaking balloon. Observations with ascent rates of 500 meters per minute or higher should be checked closely for a possible leaking or failed pressure sensor. If a leaking or a failed pressure sensor is discovered all data from that point in the flight should be deleted and the flight terminated.

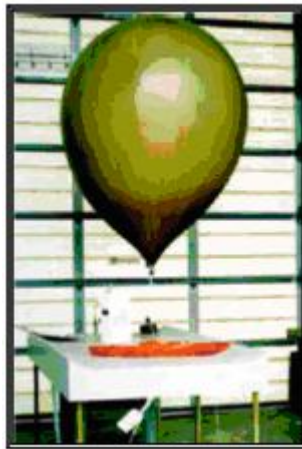


Figure C-1 - General Purpose Balloon

**2.2 Severe Weather Upper-Air Soundings:** When high winds or moderate or greater icing or heavy precipitation is expected a high-modulus balloon should be used. These balloons are designed to not stretch or elongate during high winds and ascend rapidly to diminish the effects of icing. These balloons may obtain ascent rates of 400 to 450 meters per minute when extra inflation gas is used to overcome high winds or possible icing conditions. Ascent rates 500 meters per minute or greater should be checked closely for a possible leaking or failed pressure sensor.

**2.3 High-Modulus Balloons:** Changes within the design of sounding balloons over the past few years have made a high-modulus or more spherical balloon available. High-modulus balloons minimize the problems encountered during high winds and icing conditions while achieving burst heights approaching heights achieved with general purpose balloons.

NWS field offices may be asked to fly other upper-air balloons in support of special projects or because of unusual site conditions. These balloons will not be used routinely for the NWS synoptic and NWS supplemental upper air observations unless specific approval has been granted by the NWS Upper-Air Program Office. See Figure C-2 page C-3 showing a high-modulus balloon being released from a balloon inflation launch shelter (BILS).



Figure C-2 - High-Modulus Balloon Launch

3. **Flight Performance:** Balloon performance is measured by the burst altitude and ascent rate. Performance is affected by the free lift, the thickness of the balloon skin, the air mass overlying the observing site, the atmospheric conditions to which it is exposed, and the size and shape of the balloon envelope. Since most of these factors are uncontrollable, the free lift to produce optimal performance for a given sounding can best be determined by experience.

**INFLATION LIFT REQUIREMENTS:** The amount of hydrogen, helium, or natural gas most favorable for producing optimum performance should be ascertained before actual inflation of the balloon. Lift is defined as follows:

- a. **FREE LIFT:** Free lift is the number of grams of lift that are available over and above that required by a balloon to support the weight of a complete radiosonde train.
- b. **NOZZLE LIFT:** Nozzle lift is the FREE LIFT plus the grams of lift required by a balloon to support the weight of a complete radiosonde train, excluding the weight of the balloon. (Radiosonde, parachute, light stick, dereeler or train regulator, and twine.)
- c. **GROSS LIFT:** Gross lift is NOZZLE LIFT plus the grams of lift required to support the weight of the balloon.

The amount of gas required for producing optimum performance is usually defined as the highest possible bursting altitude while maintaining an average ascension rate greater than 275 meters/minute. The balloon must be sufficiently inflated to ensure successful launch in the surface conditions which may exist at the time. These factors include, but are not limited to, the following considerations:

- 1). During fair weather conditions, optimum performance will routinely be achieved with free lift ranging from 700 to 1000 grams for 26 to 30 kilometer general purpose balloons and high- modulus balloons.
- 2). During periods of high surface winds, the chance the balloon will hit an obstruction while being removed from the inflation shelter increases substantially. The balloon must be sufficiently inflated to clear all surrounding obstacles. The use of high-modulus balloon should be considered with wind speeds of greater than 25 knots.
- 3). The performance obtained by preceding flights may be considered in selecting a free lift value to be used.
- 4). When precipitation, icing, or terrain turbulence is occurring or expected, an effort should be made to provide sufficient free lift to ensure that the balloon will not descend or float. An increased free lift of 100 grams is typically sufficient to compensate for an increase in the weight of the train resulting from light precipitation. Under light or moderate icing conditions, moderate to heavy precipitation, or terrain turbulence induced by high surface winds, an increase in free lift of from 200-300 grams will usually be sufficient. Under severe icing conditions an increase of 500 grams or more may be required.
- 5). Attach the weights required to give the desired nozzle lift to the inflation nozzle - making allowance for the part of the hose that will be supported by the balloon as well as the nozzle itself, hose clamp, cutoff valves, etc. (usually 200-300 grams).

**Note:** It is important to remember that the lift capabilities of hydrogen and helium differ. Hydrogen, the lighter of the two gases, lifts 31.8 grams per cubic foot at sea level while helium lifts 28.2 grams per cubic foot at sea level.

4. Balloon Storage and Preparation: Balloons should be stored in their original sealed containers in a room isolated from large electric motors or generators. The ozone emitted from motors and generators causes synthetic rubber to deteriorate. Ideal temperatures for storage should be in the range of 10°C to 30°C. Temperatures below 0°C or above 43°C should be avoided during storage. If by necessity, balloons are stored at temperatures below 10°C, they should be kept at room temperature of 20°C or higher for at least 48 hours prior to release. This will avoid damage that could result if balloons were removed from their containers and unfolded when they are cold.

Balloons deteriorate with age. Therefore, they should be used in the order of their production dates to avoid excessive aging. Balloons are very delicate. No part of the balloon other than the neck will be touched with bare hands. Use soft rubber gloves, soft cotton gloves, or the plastic bag in which the balloon was wrapped when handling parts other than the neck.

As a result of exposure to relatively low temperatures and extended periods in storage, neoprene balloons suffer a partial loss of elasticity through crystallization. Neoprene balloons used in this state will burst prematurely. To ensure the maximum elasticity, all neoprene balloons should be used within a year of the manufacture date of the outside of the balloon box. If an upper-air station has an electric conditioner they may use the procedures in Section 5 to enhance the performance of a balloons stored in adverse weather conditions or one that is aged.

5. Balloon Conditioning: All balloons that are over 1 year old, or have been stored in sub-freezing temperatures, should be conditioned before they are inflated using an electric conditioner if available. Under all other conditions, the conditioning of the balloons is left to the stations.

**ELECTRIC CONDITIONING METHOD:** Balloons should be conditioned for no more than 72 hours. The balloon should be removed from the plastic bag, unfolded, and placed in its cardboard box to permit uniform conditioning. Do not open the neck until the inflation nozzle is to be inserted.

When the electric balloon conditioner is used, balloons will be conditioned for a minimum of 12 hours at temperatures ranging between 60°C and 65°C (140°F to 160°F) and at a relative humidity near 100%. Four balloons may be kept in the conditioner at one time.

6. Inflation Gases: Two types of gas are used to inflate weather balloons: hydrogen and helium gas.

**HYDROGEN:** Although hydrogen gas is more volatile than helium (which is non-flammable), most land-based locations use hydrogen because of less cost. The price of hydrogen is only a fraction the cost of helium. Safe practices must be strictly adhered to when handling and using hydrogen. Hydrogen is either manufactured and bottled by a gas distributor or produced on site with a hydrogen generator.

**HELIUM:** Helium is safe and easy to use for inflating balloons. Unlike hydrogen, helium is an inert gas and does not pose a fire potential. However, helium must be mined as a by-product and is limited in quantity. The Bureau of Mines within the Department of the Interior controls the supply of helium to independent distributors.

## APPENDIX D - PRE-FLIGHT PREPARATIONS

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1. Introduction: Pre-flight preparations are an integral part of ensuring a successful Upper air operation. Care taken during pre-flight decreases the chances of having failed flights due to defective parts or from using improper procedures. The observer must follow safety procedures that pertain to the site as indicated in Appendix K and should be observant of changing weather conditions that may affect the decision on the flight train components, amount of gas, and the type of release that should be attempted.

Observers should routinely look at the upper level wind charts and the wind profile from the Weather Service Radar (WSR-88D) display if available. The information provided from sources should help the observer decide which type of balloon and train components to use and what direction the balloon should travel upon release. Knowing this information along with following proper pre-release procedures, should help increase the chances of a successful signal lock-on and flight.

2. Flight Train Components:

2.1 Balloon: The upper-air balloon must be properly inflated, tied, and secured before other flight train components are fastened onto the flight train cord. Before the balloon is removed from the inflation nozzle, close the cylinder valve to shut-off the gas from the cylinder. Release the remaining gas in the line by pulling the switching column down and then tie the balloon neck shut (See Figures D-1 and D-4). Remove the balloon from the nozzle. Secure the balloon inside the inflation shelter by tying it to a hook or the measuring weights. Next, carefully fold the balloon neck upward and tie with a square knot. See Appendix C for information on balloon type and proper procedures for balloon storage, handling, and conditioning.



Figure D-1 - Observer Tying Off Balloon before Launch.

2.2 Train Cord: The train cord should at least be a 20-ply string with a minimum of 25 meters length. A doubled 2 meter length of cord is needed between the neck of the balloon and the parachute. The remaining train length will usually be a single 20-ply string tied from the bottom of the parachute to the radiosonde.

Use a train length of 25 to 35 meters under routine conditions. Trains of less than 25 meters in length should never be used. Short trains increase the risk of the radiosonde being too close to the radiation environment of the balloon or of encountering the balloon's wake as it ascends thereby placing the radiosonde in a disturbed and unnatural atmosphere. Erroneous temperatures and relative humidity may result.



Figure D-2 - Balloon in Flight with Train

2.3 Parachute: Parachutes will be used at all stations unless NWS Headquarters issues a station waiver. The color of the parachute is bright orange that can be distinguished from the sky background during daytime operations. The parachutes are designed so that the flights train falls at a rate 10 m/s (22 mph) or slower by the time it reaches the ground.

If a waiver has been approved by NWS Headquarters, parachutes may be optional in areas where:

- a. Risk of injury is virtually non-existent, and;
- b. Risk of property damage is very negligible.

2.4 Train Regulator and Dereeler: For other than routine release conditions, particularly for high winds, observers may be required to use a train regulator or dereeler. Use a maximum of 2 meters of doubled cord between the neck of the balloon and the parachute, and then tie the train regulator or dereeler to the bottom of the parachute and the ring or loop at the top of the radiosonde to the free end of the train regulator or dereeler. Train regulators and dereelers enable the observer to launch an instrument without having to contend with many yards of slack twine or having to chase the balloon to release the radiosonde.

When a train regulator is used, the balloon is held in one hand and the train regulator and radiosonde are held in the other. The train regulator is held in such a way that neither the weight of the radiosonde nor the lift of the balloon unwinds the cord until release. At launch, the balloon is released and almost simultaneously, the radiosonde is released. As the balloon rises, the weight of the radiosonde causes the cord to unwind from the train regulator or dereeler.

The radiosonde train regulator consists of a frame, reel, and braking mechanism. The regulator is furnished with approximately 30 meters of twine or nylon tape wound on the reel. The braking mechanism permits the weight of the radiosonde to unwind the twine at the nominal rate of 1 meter per second. The regulator is designed to withstand the stresses placed on it in routine use. Care must be exercised to avoid unnecessary strains which might ruin the gear train and braking mechanism.

Before using a regulator, test it by firmly pulling about 2 meters of cord from the reel. Should the reel feed out too rapidly, it may be adjusted by squeezing the metal braking pawls together with pliers. If the braking pawls are too tight, the regulator will not feed out. To use, place the free end of the twine through the eye or over the spacer at the bottom of the regulator. Tie the twine to the supporting ring or loop at the top of the radiosonde. Determine that the regulator functions properly when supporting the weight of the radiosonde. Then, rewind the twine by rotating the reel manually.

The dereeler is a plastic apparatus that toggles back and forth as the line is pulled off the dereeler due to weight of the radiosonde. It is a very simple device that requires care in making sure the dereeler is securely tied to the cord or balloon if no parachute is required.

2.5 Shock Unit: During high winds, a shock unit may be used in the radiosonde train between the regulator and the radiosonde if vibration caused by the inconsistent unwinding of the regulator is expected to produce an unstable signal. The shock unit may be formed by tying together in parallel four 0.125 inch wide rubber bands. The rubber bands are tied to the cord of the train in such a way that the cord is slack between the ends of the bands, thereby permitting them to flex and extend when the line goes under tension. In this way, the shock unit acts as a shock absorber.

2.6 Light Stick: Most tracking systems require the observer to visually track the radiosonde and manually adjust the antenna position to ensure the receiving system is locked onto the radiosonde's signal. This can be a problem at night or in poor visibility if the radiosonde's trajectory is expected to experience large changes in direction. (e.g., from low level wind shear, restricted visibility or low cloud heights, or high elevation angles due to calm or light winds at release).

When visibility is restricted or at night, the observer should ensure a lighting unit is attached to the flight train to facilitate visual tracking of the balloon for the early part of the observation. The lighting unit will also help the observer relocate a flight train higher in the ascent if the receiving system has lost the main signal.

The lighting unit intensity should be such that the radiosonde's position can be distinguished from the background for at least five minutes. The National Logistics Supply Center (NLSC) stocks various colored light sticks that are attached to the flight train. Care must be taken to ensure that lighting units will not interfere with the braking mechanism of a train regulator. This can be successfully accomplished by tying the light unit near the balloon's neck with little slack to keep the light stick from swinging in the wind.

2.7 Radiosonde: The radiosonde is tied to the flight train so that it holds the lowest position in the radiosondes flight train. See Appendix A for information on NWS radiosonde types, performance, and operational requirements.

3. Flight Train Requirements:

3.1 High Surface Wind: Under high wind, (e.g., 25 kt) a train regulator or dereeler may be required. The observer should tie the end of a 2 meter length of double cord to the neck of the balloon and the parachute. The train regulator or dereeler should then be tied to the bottom of the parachute with the radiosonde attached to the line from the train regulator or dereeler. The balloon should be inflated to attain a nozzle lift that is 10% to 20% greater than fair weather launches.

Launches in very high wind conditions (e.g., 40 kt) pose special problems in protecting the flight equipment until it becomes airborne. The balloon should be inflated to attain a nozzle lift that is 20% to 30% greater than fair weather launches. Observers should use a high-modulus or severe weather balloon along with a train regulator or dereeler for high wind launches. The observer may fasten a shock unit (see Section 2.5 page D-5) between the regulator and the parachute to dampen vibrations that could impair data telemetry from the radiosonde. Assistance from other personnel may be required to avoid obstructions and to ensure a successful launch.

3.2 Heavy Precipitation: The observer may attach a light stick to visually improve locating the radiosonde to allow manual adjustment of the tracking antenna. The balloon should be inflated to attain a nozzle lift that is 10% to 30% greater than fair weather launches.

3.3 Moderate to Severe Icing: When moderate to severe icing is anticipated the observer should increase nozzle lift. (See Appendix C Section 3). A standard rule of thumb should be to increase the nozzle lift by 300 grams when moderate icing may be anticipated and 500 grams or more when severe icing is expected. The observer should use a high-modulus balloon.

4. Balloon Inflation Launch Shelter (BILS) Requirements: Because the BILS are located in areas having a restricted or confined release area plus the hatch opening of the BILS being of limited size, high-modulus balloons with a train regulator or dereeler are required for all launches. The high-modulus balloons are more durable and symmetrical, thereby facilitating an easier release than a general purpose balloon. The balloons also ascend at a more rapid rate. The train regulator or dereeler allows the flight train to exit the launch shelter without becoming entangled or striking objects.



Figure D-3 - High-Modulus Balloon Released from BILS

5. Balloon Inflation: The balloon inflation should begin no more than 45 minutes prior to release. Safety procedures must be followed.

5.1 Safety Procedures: Place the balloon where it will not come into contact with sharp objects or rough surfaces. If the dimensions of the inflation shelter permit, the balloon should be placed on a table for inflation. The table top should be smooth, free from projections and have all edges rounded. The table top should be cleaned frequently. To reduce abrasion during inflation, the table should be large enough so the balloon can be fully extended before the inflation is started.

If it is not practical to use a table, the balloon should be placed on a clean surface with all objects that have sharp points removed from the immediate vicinity of the balloon. Place the inflation nozzle in the neck of the balloon and secure it with a clamp, soft cord, or other suitable device which won't damage the balloon (See Figure D-4 page D-8).



Figure D-4 - Tying Off the Balloon

5.2 Proper Inflation Rates: **HYDROGEN:** When hydrogen is used, open the valve to a pressure not exceeding 15 psi (See Figure D-5 page D-9). Inflation should take no less than 7 minutes. If the balloon is rapidly inflated with hydrogen gas the likelihood of generation of static electricity is greatly increased and with it, the hazard of a fire or an explosion.





Figure D-5 - Gauge Measuring Hydrogen Line Pressure

**HELIUM:** When using helium, inflate the balloon at a sufficiently slow rate to ensure uniform expansion. If the gas regulator or outlet valve is equipped with a low pressure outlet gauge, open the valve to a pressure not exceeding 20 psi. When a low pressure outlet gauge is not available adjust the flow of gas so a minimum of 7 minutes are required to inflate the balloon completely.

**NATURAL GAS:** The same precautions mentioned for the use of hydrogen apply to the use of natural gas.

5.3 Hydrogen Safety Switch: There are two methods for inflating balloons using the hydrogen safety switch. Method I allows the observer to stay outside the inflation building while the balloon is inflated. Method II allows the observer to stay inside the inflation building. Either method may be used at the discretion of the observer.

#### HYDROGEN INFLATION METHOD I

To implement method one, proceed as follows:

- a. Be sure the valve on the hydrogen tank is closed.
- b. Be sure the power switch on the control box is OFF.
- c. Connect the balloon neck to the inflation nozzle in accordance with established procedures.
- d. Be sure the rotating latch is in the lower rest position.
- e. Align the rotating latch with the oval-shaped hole so that it is free to rise to the upper limit of travel.



- f. Open the valve on the hydrogen tank.
- g. Set the regulator to provide the prescribed pressure: 15 psi.
- h. Throw the power switch on the control box to the ON position.
- i. Depress the start switch on the control box to initiate the flow of hydrogen. The opening of the solenoid valve is indicated by a lighted indicator lamp on the control box. Continue to hold the start switch in its actuated position until the balloon has attained sufficient buoyancy to raise the rotating latch to the upper limit of travel. When this occurs, be sure that the rotating latch is aligned with the oval-shaped hole in order to retain the safety feature of the hydrogen switch. This alignment will permit the rotating latch to drop to the lower rest position if a balloon bursts during inflation. This action automatically cuts off the flow of hydrogen.
- j. Release the start button. Inflation will continue until the balloon has reached its predetermined lift. At this time, the balloon will rise and lift the switching column from the rest position. In so doing, it will cause the lower reed switch in the switch post to open. This action deactivates the solenoid switch and cuts off the flow of hydrogen.
- k. Turn off the valve on the hydrogen tank.
- l. Pull the switching column down on the switch post momentarily to the rest position. This will open the solenoid valve and relieve the pressure in the inflation hose between the hydrogen tank and the solenoid valve.
- m. Turn the power switch on the control box to the OFF position.
- n. Tie off the neck of the inflated balloon in accordance with existing instructions (see Section 5.4.4. page D-11).

## HYDROGEN INFLATION METHOD II

*Method II assumes the same procedures as Method I, except steps i and j are replaced with the following three steps.*

Using this method, gas flow is initiated by raising the rotating latch from the lower rest position to the upper rest position. With the rotating latch locked in the raised position, it is not necessary to depress the start switch at any time in the inflation cycle. Inflation will continue as in method one until the balloon has attained sufficient buoyancy to lift the switching column on the switch post.

Proceed as follows:

- a. Raise the rotating latch to the limits of travel and lock it into the UP position. This action will initiate the flow of hydrogen into the balloon.
- b. After the balloon has attained sufficient buoyancy to hold the rotating latch at its upper limit of travel, realign the latch with the oval-shaped hole in order to retain the safety features of the hydrogen switch.
- c. Inflation will continue until the balloon has attained sufficient buoyancy to lift the switching column from the rest position on the cover of the junction box. In so doing, it will cause the lower reed switch to open. This action deactivates the solenoid switch and cuts off the flow of hydrogen.

#### 5.4 Inflation Procedures:

5.4.1 First Stage of Inflation: When the balloon has been prepared and inflation equipment (cylinders, hoses, clamps, safety switches) are confirmed to be in good order, begin the inflation of the balloon in accordance with guidelines stated in section 5.3.

5.4.2 Intermediate Inspection: When the balloon is about one-half inflated, close the gas valve. Listen for gas leaks and examine the balloon for defects. Serious defects may result from foreign materials in the neoprene, a break in the balloon skin, or a deformity in a small area of the neoprene film. Discoloration should not be regarded as a defect unless experience indicates that certain types of discolorations result in premature bursting. If the balloon is defective, reject it and begin inflating a second balloon. Otherwise, proceed with inflation.

5.4.3 Final Inflation: Once the balloon is at least partially inflated check to ensure the balloon is not in contact with the ceiling of the inflation shelter or other surface. If the balloon is likely to touch the ceiling before the desired lift has been reached, proceed carefully with the inflation and secure the balloon in a manner to minimize or eliminate possible contact with the ceiling or other objects. Sites having low ceilings should use padding or netting to ensure the ceiling is smooth and protected by soft material.

5.4.4 Securing the Balloon: Tie the neck of the balloon with a doubled cord as soon as inflation is completed. Make one turn of the cord around the neck of the balloon near the center (close to the top of the inflation nozzle). Pull the cord as tightly as possible and tie with a knot. Make another turn around the neck and tie again. Remove the balloon from the nozzle, fold the neck upward and again tie the neck just above the first knot. Be sure that all cord is below the area where the neck starts to flare out to join the envelope of the balloon. The balloon should be left in the inflation shelter until preparations for the release have been completed.

5.5 Launch Delays: Balloon inflation should not occur earlier than 45 minutes prior to release. Allowing the balloon to be inflated an extended period of time before the launch causes undue strain on the balloon and is likely to cause premature bursting. At sites using helium, the balloon may be allowed to rest against the ceiling of the inflation room provided the ceiling is smooth and free from projections or rough spots. Balloons inflated with hydrogen or natural gas

will not rest against surfaces other than an anti-static balloon cover or shroud once removed from the inflation nozzle.

5.6 BILS System Inflation: Inflation at sites using a BILS is slightly different. The BILS sites use a gas meter to fill the balloon with the appropriate amount of helium. The amount will range from 65 to 85 cubic feet. Currently the observer is required to manually shut the valve off once the desired cubic feet of helium have been placed in the balloon.

6. Fastening the Flight Train Together: Whenever possible, the station workload should be arranged so that release can be made within a few minutes following the testing and calibration of the radiosonde. The flight train should be completely assembled and ready for launch within 20 minutes from the time the battery cell was activated. The train is usually assembled during the balloon inflation process which is performed 30 to 45 minutes prior to release. Flight train assembly at the time of launch should be avoided and should only be done if the observer is sure that launch will occur within 20 minutes of battery activation time.

Proper assembly of train (i.e., the balloon, parachute, radiosonde, and launching devices which may be used) is critical to the success of the observation and the accuracy of the data. Improper train assembly could result in:

- a. Undue strain on the balloon neck and premature termination of the flight.
- b. Unrepresentative sensing of the atmosphere.
- c. Entanglement of components.
- d. Higher risk of collision with ground based obstacles.
- e. An increased hazard when the radiosonde flight train descends if the parachute doesn't deploy.

#### 6.1 The Initial Tying of Lines onto the Parachute and Balloon:

- a. Tie a 2 meter length of double strand 20-ply cord to the top of the **parachute**. Leave free the other end of this cord. (If a parachute is not required, see Section 6.3 for instructions.)
- b. Follow procedures outlined in Section 5.4.4 page D-11 on securing the balloon.
- c. If a shock unit is necessary, see Section 2.5 page D-5 for a description.

6.2 Linking the Train Regulator or Dereeler to the Flight Train: When a train regulator is to be used follow these procedures:

- a. Tie the train regulator or dereeler to the lower end of the parachute. Care must be

exercised when using a dereeler to ensure that the dereeler is secured properly. This may be accomplished by making several wraps around the dereeler when securing it to the lower end of the parachute or by adding another .3 to .6 meters of doubled string between the bottom of the parachute and the dereeler.

- b. If a parachute is not used, ensure the doubled-cord is secured firmly around the **train regulator's** spindle (axle). If a dereeler is used, it should be secured to the balloon by placing the dereeler handle in the fold of the neck of the balloon and secured firmly with several knots to ensure the handle can not slip out.

6.3 Tying the Flight Train without a Parachute to the Balloon: The final phase of the flight train assembly is to link the train assembly to the balloon. The assembly is dependent of the flight train's configuration.

- a. For flights that require **neither a parachute nor a train regulator/dereeler**: Follow the instructions in Section 6.1.b. Fasten the free end of the 2 meter doubled cord to a 23 - 35 meter length of single 20-ply cord with the free end attached to the radiosonde.
- b. For flights that require a **Vaisala dereeler** but no parachute: Follow the instruction in section 5.4.4, but place the handle of the **Vaisala dereeler** at the point on the neck of the balloon where the original knot was tied and then fold the neck up and secure the dereeler by wrapping several turns of the doubled cord around the dereeler hook or arm and tying a tight knot. Release the suspension string from the slot of the dereeler and tie to the metal eyelet on the top of the instrument.
- c. For flights that require a **train regulator** but no parachute: Fasten a 2 meter - length of doubled-cord to the balloon's neck following procedures shown in section 5.4.4 titled securing the balloon. Then secure the end of the remaining amount of doubled-cord to the **train regulator**. The line from the train regulator should then be tested by firmly pulling a small length of line from the regulator and attaching it to the radiosondes eyelet.

## APPENDIX E - LAUNCHING PROCEDURES

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1. Introduction: This appendix pertains to the sequence of events after the balloon has been inflated that lead to balloon launch. Some minor modifications to the procedures may occur, but the sequence of events should remain basically as outlined. These procedures along with instructions provided in the MicroART or RRS Training Guide should provide the observer with enough guidance to successfully prepare and launch the radiosonde.

2. Synoptic Schedule Requirement: The standard times for scheduled synoptic observations are 0000 UTC and 1200 UTC. Release times should be scheduled as close as conditions permit to 2300 UTC and 1100 UTC, but no earlier.

Delayed synoptic releases are usually due to radiosonde or ground equipment problems or when a 2nd release is required. Releases may be made after the standard times of observation, but no later than 0100 UTC and 1300 UTC. This schedule ensures the upper air observational data are available to initialize the 0000 UTC and 1200 UTC numerical weather prediction models. The major actions required for a successful release are outlined in Tables E-1 and E-2.

The actual time of release is expressed in hours and minutes UTC and is automatically recorded to the nearest minute for use in the "TTBB" coded message in MicroART and in all coded messages using RRS software.

3. Non-Synoptic Observations: For all non-standard observation times the release window, in regard to the recorded time of the observation, is from 30 minutes before to 29 minutes after the hour of assigned observation time. Ex: release at 0231 UTC would be for the 0300 UTC flight, a launch at 0510 UTC would be for the 05 UTC flight.

4. Overall Pre-launch Sequence: The ability to determine when and how to vary the sequence steps will relate to the observer's experience level. Understanding that a key part to having consistent successful launches is to form a pattern of performing these operations with the ability to adjust for possible changes due to instruments, weather conditions and even ground equipment limitations. (See Table E-1 page E-5 that illustrates these steps and approximate times the steps should be performed for sites using Radio Direction Finding (RDF) tracking equipment.)

a. Observer Actions Prior to RDF Radiosonde Launch. The pre-launch sequence has three main components:

- 1). Balloon Inflation and Train Assembly.
- 2). Weather Station Operations:
  - a. Equipment Warm-up and Orientation.
  - b. Entry of Preflight Information.
  - c. Instrument Baseline.
  - d. Antenna Positioning.
- 3). Release Site Processes:
  - a. Final Train Preparations.
  - b. Launch Approval.
  - c. Possible Repositioning of Antenna.
  - d. Decision on Method of Launch (Timed or Manual).

b. Observer Actions Prior to GPS Radiosonde Launch - The pre-launch sequence has three main components:

- 1). Balloon Inflation and Train Assembly.
- 2). Weather Station Operations:
  - a. Equipment Warm-up and Hardware Status Check.



- b. Entry of Preflight Information.
  - c. Instrument Baseline.
  - d. Final Antenna Positioning.
- 3). Release Site Processes:
- a. Final Train Preparations.
  - b. Launch Approval.
  - c. Possible Repositioning of Antenna.
  - d. Decision on Method of Launch (with or without CDU).
  - e. After Release with the CDU, Verify Signal Strength, Frequency and Tracking.

Table E-1 - Sequence Actions Prior to Launch (RDF). Launch time is marked as T-00 minutes.

T- 45 minutes	Turn power on at MCU. Begin filling the upper-air balloon and prepare the flight train. <b>(Ground equipment needs at least 15 minutes to warm-up)</b>
T-20 minutes	Thoroughly inspect radiosonde and components. If required, insert humidity sensor into the radiosonde. <b>If using a VIZ radiosonde, place on the power supply for at least 5 minutes.</b>
T-19 minutes	Start MicroART. Do a System Status Check. Open and update the administrative data file.
T-16 minutes	Update Flight Equipment Data and Radiosonde Serial Number in the MicroART Prerelease Data.
T-15 minutes	Place radiosonde battery cell in water to begin its activation.
T-12 minutes	After battery has reached acceptable voltage, install battery in radiosonde. <b>Place radiosonde on Styrofoam block or suspend to avoid erroneous frequency readings.</b> (Position antenna to point at radiosonde)
T-11 minutes	Monitor ART console's readouts to check for the proper radiosonde transmitter frequency and signal strength values.
T-10 minutes	Take and enter the surface observation to MicroART's Surface Data Screen.
T-09 minutes	Start the baseline procedure on the MicroART workstation. Compare the instruments pressure reading with the station pressure.
T-08 minutes	Place log disk in the MicroART A: drive.

T-07 minutes	Adjust antenna elevation and azimuth for release then, depart for the release site. (Motors must be in Standby)
T-04 minutes	Open remote release panel, turn on power, and turn up speaker volume. Check for clean signal.
T-03 minutes	Tie the radiosonde to the assembled flight train.
T-02 minutes	Check the flight-train's integrity and visually survey the release zone and the anticipated path of flight. Minimize potential for obstacles.
T-01 minutes	Phone the local airport control tower and request flight clearance. Monitor ART remote panel for signal quality and ensure ART antenna is positioned to best track the radiosonde through its expected path.
T-00 minutes	Observer should routinely <b>do a timed release</b> to eliminate missing data for the first few seconds of the flight. Not starting the equipment at release will cause height errors as well.

Table E-2 - Sequence Actions Prior to Launch (GPS). Launch time is marked as T-00 minutes.

TIME TO LAUNCH	OBSERVER ACTIONS FOR GPS RADIOSONDE
T- 45 minutes	Begin filling the upper-air balloon and prepare the flight train. <b>(Ground equipment may need to be turned on in colder environments)</b>
T-30 minutes	Start RRS workstation. (The TRS may take 30 minutes to warm-up). The TRS Status Line on the Antenna Orientation/TRS Display will indicate Initialization Completed.
T-22 minutes	Thoroughly inspect radiosonde and components.
T-20 minutes	Update Flight Equipment Data.
T-17 minutes	Place radiosonde battery cell in water to begin its activation. (2 Minutes)
T-15 minutes	Install battery in radiosonde.
T-13 minutes	Set frequency on the instrument and then set the frequency in the Antenna Orientation/TRS Display window. Manually move the Antenna to the baseline point. (Verify the signal strength values are acceptable).
T-10 minutes	Complete the Surface Observation Display.
T-09 minutes	Start the baseline procedure on the RRS workstation. Battery must be in the radiosonde a minimum of 5 minutes prior to starting baseline. Compare the instruments pressure reading with the station pressure. If within $\pm 5$ hPa and the temperature, relative humidity values look reasonable - accept.
T-08 minutes	Adjust antenna elevation and azimuth for release, and then depart for the release site. (Antenna must be placed in the Manual Track Mode)

T-05 minutes	Check the RCDU to ensure frequency has not shifted off the sonde and the signal is strong. Double check to ensure the Antenna is positioned to the appropriate azimuth and elevation. Turn up the volume of the CDU. You should hear noise - That noise is the radiosonde.
T-04 minutes	Tie the radiosonde to the assembled flight train.
T-03 minutes	Check the flight-train's integrity and visually survey the release zone and the anticipated path of flight. Minimize potential for obstacles.
T-02 minutes	Phone the local airport control tower and request flight clearance.
T-01 minutes	Position the RCDU for easy access after launch if using the primary launch method shown in Section 13.2.1.
T-00 minutes	The observer should release the radiosonde and use the RCDU to lock-on to radiosonde for all launches other than method 2 shown in Section 13.2.2.  Note: Before leaving the Release Site validate the receiver is still locked on the radiosondes frequency and the signal is acceptable.

## 5. Equipment Warm-up:

5.1 ART Tracking Equipment Warm-up: The ART tracking equipment must be warmed up a minimum of 15 minutes prior to doing a status check and checking the antenna orientation. Turn the power switch on at the Master Control Unit (MCU) and make sure the motors are in standby.

5.2 RRS Tracking Equipment Warm-up: RRS tracking equipment warm-up will vary mainly due to change in temperature within the radome. A status message, "TRS Reset init in progress" will appear in the Antenna Orientation/TRS display once the TRS warm up is completed. The flight can not proceed until the warm-up is completed. A minimum of 30 minutes warm-up time is required prior to launch.

**Note:** The SPS requires a minimum of 12 minutes warm-up prior to initiating the "Baseline Check".

## 6. Preparing for Antenna Orientation:

6.1 ART Antenna Orientation: After the tracking equipment has warmed up, take the motors out of standby on the MCU and position the antenna manually within a few degrees of the documented azimuth and elevation points for the target antenna. Turn the target antenna switch on and allow the antenna to lock on the target antenna by pressing the FAR AUTO button. (Low sensitivity OFF)

6.2 RRS Antenna Orientation: Antenna orientation with the RRS tracking equipment is not critical as with RDF tracking equipment. Using the "RRS Antenna Display" window on the RRS workstation, the antenna should be positioned within a few degrees of the baseline point prior to beginning the baseline check. Setting the frequency and then placing the antenna in "Search"

will allow the antenna to hone in on the radiosonde signal prior to baseline.

## 7. Obtaining Status Check and Orientation:

7.1 ART Equipment Checks: Turn on the MicroART computer. Select ART Options and select Check System Status. The check of the ARTIC card and SPU-11 board (For Vaisala radiosondes) if installed will be tested as will the printer and modem. When the Status Check is completed the orientation check section appears. When the angle readings stabilize and both of the new corrections are less than 0.05 degrees press [Enter] to save them. If unable to get the readings within 0.05 degrees repeat the orientation check following the procedures in Chapter 7 of the MicroART Training Guide.

7.2 RRS Hardware Status Checks: Turn the RRS workstation on and log in with Username and Password. After the Security window appears and the Live Flight Option is selected. The Hardware Status window appears. The various components except for the SPS and GPS should have a green check mark when operating properly. The SPS and GPS status can not be determined until a radiosonde has been prepared and connected to the battery during the baseline process. Chapter 7 or the RRS User Guide titled “Checking the Hardware Status” provides detailed information on the various hardware components checked and recommended actions.

8. Enter Pre-Release Data into MicroART: Follow instructions on entering Administrative Data, Flight Equipment Data, Radiosonde Data, and Surface Data shown in Chapter 8 of the appropriate training guide.

8.1 Administrative, Flight Equipment, and Radiosonde Data: This information is easy to follow, menu driven, and requires little explanation.

8.2 Surface Observation at Release Site: Take a complete surface observation within ten minutes of the time of release and enter the data into Surface Observation Display. Whenever the surface observation is not taken within 10 minutes before release time, it should be retaken as soon as possible after the release. RRS sites having RSOIS may access the RSOIS and PDB readings during Pre-Release and automatically get the updated values from the software at release.

8.2.1 Pressure: Station pressure is obtained from a NWS approved Precision Digital Barometer (PDB) corrected to read the height at the baseline point or the height at where the instrument is baselined in the office. Readings will be entered to the nearest tenth of a hectopascal. When the surface pressure is less than 1000 hPa, the temperature entry from twelve hours ago will be entered to allow the software to estimate the 1000 hPa height or other heights for mandatory pressure levels less than being observed. In addition, the digital barometer’s surface pressure will automatically be registered into the flight log and, under usual circumstances; an adjustment will be made to the radiosondes pressure reading to make it the same as the digital barometer’s reading. If necessary, the observer may edit an incorrect surface pressure value. Instructions on editing surface data are covered in the appropriate user training guide.

The MicroART software has a significant difference between the Vaisala software and VIZ software. VIZ sites may reenter the Surface Data screen anytime during the flight, but Vaisala sites are only allowed to reenter the Surface Data screen for just the first few minutes after release. The Vaisala SPU-11 card uses the value to generate future data points and once locked-in it can not be changed. Therefore, it is important that the surface data be verified as soon as possible after release. The RRS software allows the operator to change the Surface Observation anytime during or after the flight.

The PDB's are re-certified for accuracy annually per the NWS standard for barometers. Each year, the standards laboratory automatically replaces the PDB's with programmed value (elevations and R values) put into the instrument for all sites. The PDB's have special boxes to protect the instrument.

8.2.2 Temperature: Record the dry bulb temperature to the nearest tenth of a degree Celsius.

8.2.3 Dew Point: Record the dew point temperature to the nearest tenth of a degree Celsius. When entering the Surface Observation, check to confirm the dew point temperature is valid and does not exceed the surface temperature.

8.2.4 Wind Direction and Speed: Enter the wind direction to the nearest 5 degrees in MicroART. The RRS software allows winds to be entered to the nearest whole degree. For calm winds, estimate a direction or use 360 degrees. The wind speed is measured or estimated to the nearest knot. For calm winds, a single zero (0) can be entered for wind speed.

8.2.5 Clouds and Weather: Enter the nine digit code that contains the weather at the observation time. The clouds/weather part of the observation uses a modified WMO format in order to meet NCDC requirements for clouds and present weather. Appendix B of the MicroART Training Guide explains the following code for the upper air observation.

**$N_h C_L h C_M C_H WWWW$**

**$N_h$**  - Amount of sky covered in oktas (eighths) by low clouds, or if no low clouds are present, coverage by middle clouds

**$C_L$**  - Type of low cloud

**$h$**  - Height of the lowest cloud base

**$C_M$**  - Type of middle cloud

**$C_H$**  - Type of high cloud

**WWWW** - Present weather coded in two groups of WW. Enter the two code groups from Appendix B of the MicroART Training Guide (with highest numerical priority) that best represent the site's weather. (Note that some code groups refer to weather during the previous hour but not at the time of observation.) The code with the highest priority should appear first. If only one WW group is applicable to the present weather, then use that code twice.

EXAMPLE: The following clouds/weather condition would be encoded 657082001.

- 6 - 6 oktas sky coverage by low clouds.
- 5 - Stratocumulus clouds (not formed by the spreading out of cumulus).
- 7 - Cloud bases between 5000 and 6500 feet.
- 0 - No middle clouds.
- 8 - Cirrostratus clouds (not covering the whole sky and not invading the celestial dome).
- 20 - Drizzle during the preceding hour, but not at the time of observation.
- 01 - Clouds generally dissolving or becoming less developed during the past hour.

To validate the cloud/weather code, ensure that: (a) nine digits were entered, and (b) the field was not all of one character (e.g., //) or does not contain letters or other characters (e.g., A, X, \$).

**8.3 Check the Radiosondes Sensor Accuracy:** The observer must check the real-time surface pressure (P), temperature (T), and relative humidity (U) values as measured by the radiosondes sensors displayed during the baseline process. Care must be taken to obtain the best possible signal and eliminate possible antenna loading. The ART antenna motors should be in standby, and the instrument should be placed on a Styrofoam block or hung by a string.

The RRS GPS tracking antenna should be pointed at the radiosonde and set to the proper frequency and placed into the "Auto" mode to lock-on the radiosondes signal. After locking on the instrument's signal the Antenna should then be placed in the "Manual" tracking mode. This will eliminate antenna movement and noise during baseline.

Present baseline procedures only allows for a comparison of pressure values. If the pressure value is  $\pm 5$  hPa off from the approved station pressure measuring device, the baseline should be run again, if the error still exists, reject the instrument. It is important to remember that only the pressure sensor is actually being compared with the instrument inside the office. The temperature and dew point readings the radiosonde is compared to are located outside the office. The temperature or relative humidity sensor may be considered out of tolerance if the readings themselves are considered by the observer to be unrealistic (i.e., 105% RH or 60<sup>0</sup> C.) The observer may place the radiosonde outside near the surface observation equipment to verify the accuracy of the instrument's temperature and dew point measurements.

Discrepant radiosonde meteorological data may be the result of air trapped within the sensor duct or water vapor from the wet battery. The radiosonde should be held at arms length and swung back and forth to force ambient air across the sensor surfaces. If inaccurate values persist, another possible explanation is the calibration data are incorrect, or there is a material defect in the sensor itself.

Continue to monitor the Surface Data Screen values and if P, T, U values are out of tolerance (e.g.,  $> \pm 5.0$  hPa) then select and prepare another radiosonde to replace the discrepant one.

## 9. Baselining the Radiosonde:

9.1 Baselining the RDF Radiosonde: Ensure the battery is activated and properly positioned within the radiosonde. Next, set the radiosonde upon an insulated block or similar object (do not set on a table or cabinet). Align the antenna so that it is pointing at the radiosonde. Allow the antenna to lock-on the strongest signal before placing the motors in standby. Verify the transmitter's signal strength and the receiver's ability to lock onto the proper frequency with the ART console meter. Note the meter readings. Ensure the carrier frequency is within  $\pm 5$  MHz of 1680 MHz. Signal strength should be at least 60 dB. The signal check should be completed approximately 10-15 minutes before release.

Check the automatic frequency control (AFC) meter to ensure the transmitter signal is being received clearly. If the AFC indicates signal fade or drift, reposition the radiosonde and check again. If the signal is still unacceptable, check the battery strength and replace the battery if necessary. If AFC still fails to achieve lock-on, replace the radiosonde. Follow the baselining procedures described in Chapter 8 of the MicroART Training Guide.

9.2 Baselining the GPS Radiosonde: Ensure the battery is activated and properly positioned within the radiosonde. Set the frequency on the radiosonde. Align the antenna so it is pointing at the radiosonde. Click the "Set" button in "Antenna Orientation/TRS Display" window and enter the desired frequency. The signal strength should increase once the frequency is located. The signal may be off the frequency that was set by .1 or .2 MHz, click the "AFC" button. Go ahead and select the "Auto" Track Mode to ensure the RRS antenna locks-on to the strongest signal and is pointed to the desired position. Prior to starting the baseline ensure the radiosonde has been on battery power a minimum of 5 minutes. Next, place the antenna back into the "Manual" Tracking Mode. When the maximum signal is received click the "Next" button to move from the "Surface Observation Display" window to the "Radiosonde Baseline" display. Wait until at least 10 frames are received that look consistent, and compare with the "Station" surface data before accepting. If doing a second or third release be sure to set the frequency on the radiosonde and in the Antenna/Orientation display well prior to baseline. Do not use the "Scan" button.

10. Transportation of Instrument to Release Site: When a successful baseline is obtained, the antenna should be positioned to point in the approximate direction the balloon is expected to travel with the elevation adjusted for wind conditions. When this is completed the motors should

be placed in Standby for the sites using the ART equipment and for those using RRS the Track Mode should be placed in Manual and put in Auto after release. This will eliminate the antenna from attempting to track the instrument during transport to the inflation building. Not doing so, may cause damage to the antenna tracking system and may also cause the antenna to lose the signal and go into the “Suspend” mode. If the TRS goes into “Suspend” the RCDU will indicate “Suspend” on the display. Hold a “Slew” or “Move” button for 4-5 seconds, this should re-activate the antenna. The antenna will return to the “Manual” track mode. Push the “4” button to initiate “Auto” track.

**Note:** Sites using GPS radiosondes should be aware that GPS lock will take as much as 20 seconds to be re-established if the instrument is taken inside and tied to the flight train. Under most weather conditions, the instrument should be placed on a platform or basket and left outside with the flight train attached to it. If this is not possible, the radiosonde should be taken outside and not released for at least 20 seconds to ensure the GPS signal is re-acquired.

11. Final Inspection of Flight Train: After the balloon has been filled and the flight train has been assembled, inspect the tie points along the flight train to ensure cord connections are fastened tight. Ensure that the balloon neck is not being overly strained. Ensure the train cord to the radiosonde is untangled and will flow freely through the hand or through the train regulator. Do not forget to check the cord at the bottom of the radiosonde to ensure it has been tightened properly.

Release procedures vary with the wind conditions at the release site. The observer should be familiar with all obstructions about the area before attempting a release. Before the balloon is removed from the inflation shelter, the observer must recheck the wind direction and speed.

Visually check to confirm that the temperature and humidity sensors are properly positioned and not damaged. Ensure the battery is firmly encased within the body of the radiosonde.

Observers are reminded that high winds and heavy precipitation increase the risk of flight train entanglement in trees, high-tension power lines, and various antenna masts. To the extent possible, measures should be taken to reduce the possibility of entanglement (i.e., add extra free lift during inflation). If entanglement with a power line or antenna mast occurs, no attempt should be made to disentangle the rawinsonde. The circumstances will be reported at once to the relevant power or communications company and broadcast station.

During the release, be mindful that water from the battery may drip out. Observers should position themselves so as to avoid water dripping on them.

12. Final Safety Check: No matter where a NWS site may be located care must be exercised prior to launching a rawinsonde flight.



**The following procedures will be complied with by all NWS sites.**

12.1 Notify the Local FAA Tower: An upper-air site located within 5 nautical miles of a controlled airfield will call the local FAA Tower immediately before a rawinsonde flight and request permission to release the balloon. When the observer is given permission, a visual search of the flight area should be made. Observations taken at or near major air terminals pose a greater risk to aircraft in flight than do those which are taken in remote areas. This is especially true during the initial low level phases of the observation where there is generally a greater concentration of aircraft converging during takeoff and landing operations.

Controlled airports are illustrated in aeronautical charts with blue airport symbols. The FAA Airport Facilities Directory, which is reissued every 56 days, gives the hours of operation for the controlled airports. During hours the airport is unmanned, the procedures listed in section 12.2 for non-controlled airports will be followed.

12.2 More than 5 Nautical Miles from a Controlled Airport or at a Non-Controlled Airport:

Upper-Air Sites at or near airports which are not controlled or at which the controlling authority is not in operation will visually check the horizon to ensure there are no aircraft in the area that might be affected by releasing the radiosonde. A visual check of the horizon will be made at all upper-air sites prior to launch of the radiosonde flight train.

13. Radiosonde Launch Procedures: The observer will follow safety procedures for site-specific inflation equipment and should work to limit risk from the potential hazards that surround the release site. Special procedures should be documented in the Station Duty Manual (SDM).

13.1 RDF Radiosondes: Ensure that the MCU and RCU consoles show the receiver system is in STANDBY. Then perform the following operations:

**AT REMOTE CONTROL UNIT: (See Figure E-1 page E-20)**

- a. Press the following three push-button switches as indicated and observe listed indication.

<u>SWITCH</u>	<u>INDICATION</u>
NEAR AUTO (Ant Track)	NEAR AUTO (button lights on)
MANUAL	(button goes dark)

LIMITED (Freq Search)

LIMITED (button lights on)

MANUAL

(button goes dark)

STANDBY (Toggle off)

STANDBY (button goes dark)

- b. Operate ELEVATION and AZIMUTH switches to point antenna in the direction you expect the radiosonde to travel at release.

**NOTE:** The radiosonde must not be placed on the ground at anytime! This can cause antenna loading which will cause a frequency shift once the instrument becomes airborne. The frequency drop may be from 5 to 10 MHz. This drop in frequency may cause the receiver to go into a limited search and if the change is beyond 5 MHz a full search may be initiated that could cause the search sequence to last as long as 40 seconds.

- c. Set SIGNAL/FREQ Switch to SIGNAL LEVEL. Check for adequate signal strength.
- d. Observe AFC Indicator. This button should be lit.
- e. Set volume level of MET data signal.
- f. Press REMOTE RELEASE Switch. Release tones should be heard from the loudspeaker.
- g. Walk to balloon release site and follow standard procedures to release balloon.

**Note:** Immediately after release, an operator should stand-by to adjust antenna position if necessary, to aid the system in gaining lock-on to the radiosondes main lobe. The manual adjustment is simplified by placing the tracking mode in “Manual” rather than Near or Far Auto. Then by adjusting the ELEVATION and AZIMUTH toggle switches and possibly using the wind rose and a clinometer as aids.

- h. If the LOW SENSITIVITY indicator button is illuminated, press the button to return to high sensitivity. Indicator button should be dark (not illuminated).
- i. When the radiosonde is a sufficient distance from the antenna for smooth tracking and is not expected to go directly overhead; press FAR AUTO (Antenna Tracking) switch. The FAR AUTO switch should illuminate and NEAR AUTO (Antenna Tracking) should go dark.

13.1.1 Fair Weather Launches: Follow the procedures described in Section 13.1, Items a-i. In the warm season, particularly when taking the 0000 UTC observation, be alert to possible super-adiabatic lapse rates in the first 10 meters above the surface. Similarly, throughout the year, particularly at the 1200 UTC observation, be alert for layers in the first 30 meters above ground level that have been cooled by radiation inversions.

13.1.2 Calm Wind Launches: Follow the procedures described in Section 13.1, Items a-i. On occasion, the ART antenna will lock-up when the rawinsonde becomes positioned above the ART tracking unit. This may occur when winds are calm at the surface, or if winds bring the radiosonde over the station and into a layer of light and variable winds aloft.

When the tracking antenna is stuck in a high elevation angle position, override the AUTO tracking system and manually control the antenna to a slightly lower angle. Then search and reacquire the radiosonde's signal through full and limited-scale frequency scanning and manual antenna repositioning with visual tracking if necessary.

In many cases, the software will detect a locked antenna and automatically delete the position data during the period of the lockup. However, if this period is short, the software may not detect the lockup. See MicroART Training Guide, Chapter 9.5.3 for procedures needed to edit data (e.g., angles and winds).

13.2 GPS Radiosonde Launches: Position the antenna in the direction that winds are expected to take the instrument. There are two techniques that may be used to acquire the signal.

13.2.1 Pre-Positioning the Antenna and the CDU: The following steps are the primary method for launch:

**Note:** The antenna should be pre-positioned prior to leaving the office and placed in "Manual" tracking.

- a. Use the RCDU to readjust the pre-positioning of the antenna prior to release to an elevation and azimuth that the instrument will travel.
- b. Leave the Antenna in the "Manual" tracking mode by pressing the "5" key. Slew the antenna to validate the antenna will move. If the antenna is locked-up, hold a Slew key for 4 to 5 seconds to take the antenna out of "Suspend" Mode.
- c. After release, press the "Antenna" button and select the "4" key to "Auto" track the radiosonde. If for some reason, the antenna does not lock on the radiosonde, place the antenna in the "Manual" track mode and move the antenna to the direction the radiosonde was last seen.

**Note:** Always check the upper level winds before going to the inflation building. If GPS is lost, a reasonable approximation can be made to locate the radiosonde upon returning to the office.

13.2.2 Launches Using the RRS Workstation Only: If conditions make using the Remote Console Display Unit (RCDU) difficult such as during extremely cold or very rainy conditions or if the RCDU is inoperable:

- a. Inside the office, at the workstation pre-position the antenna in the general direction the winds will take the balloon and place in “Manual” track mode and release.

**Note:** This first step should be completed for all releases.

**Return to the Office:**

- b. If GPS is being received, place the Antenna into the “Search” mode using the Antenna Orientation/TRS Display. This will allow the antenna to find the last GPS location.
- c. If GPS has been lost, upon returning to the office go into the “Received Position Data” and enter the most recent data showing the azimuth and elevation and enter it into the “Antenna Orientation/TRS Display”. If there was no GPS use the Winds Aloft Chart and the NEXRAD radar to locate the instrument. After entering the azimuth and elevation, click the “Move Antenna” button, the antenna will move to the azimuth and elevation entered. Click the “Search” button to place the antenna in the “Search” mode.

**CAUTION:** Do not place the antenna into “Auto” this may cause the antenna to lock onto a side-lobe.

**Note:** Always check the upper level winds before going to inflation building. If GPS is lost, a reasonable approximation can be made to locate the radiosonde upon returning to the office.

13.3 Foul Weather Launches: The procedures described in Section 13.1, Items a-i, generally apply to foul weather launches for RDF radiosonde launches. Procedures described in Section 13.2.2 would be usually followed for most GPS radiosonde launches unless the weather is extremely bad or the RCDU does not work.

13.3.1 Heavy Precipitation: Heavy precipitation (rain, freezing rain, or ice pellets) is defined by the WSOH-7 as 0.30 inches per hour or more than 0.03 inch in 6 minutes. Snow or drizzle can be

estimated by visibility that is less than or equal to one quarter of a mile. This rate will place loading on the balloon and result in slower ascent rates during the first portion of the flight.

General guidelines for heavy precipitation events:

- a. Use extra gas (free lift)
- b. Possibly launch earlier or later if the precipitation is expected to move through the area or diminish in intensity.

**13.3.2 Freezing Precipitation:** Freezing precipitation can significantly slow the rawinsonde flight. Freezing precipitation can accumulate on the balloon and radiosonde. The observer should use 300 grams extra gas when moderate icing is expected and 500 grams or more extra gas if severe icing is likely.

**13.3.3 High Winds:** The observer will be aware of the obstructions around the upper air shelter before attempting a release. Before the balloon is removed from the inflation building, the wind direction and speed should be determined. Note the period of gusts and type of turbulence that could pose a risk to the rawinsonde flight release.

**13.3.4 Two - Person Technique:** If a train regulator or dereeler is unavailable or time does not permit the reconfiguration of a flight train and an assistant can lend a hand, the two person technique is recommended for high wind cases. This technique can be conducted from the NWS standard inflation shelters; however it does not apply to the confines of a Balloon Inflation Launch Shelter (BILS).

**Note:** The two observers should plan the radiosonde release in advance for the technique to be successful.

The first observer will hold the tie-ring or cord above the radiosonde in one hand, grasp the cord further up the train with the other hand and extend the train until a slight tension is exerted to avoid having the train become tangled. The second observer will then remove the balloon from the shelter; the balloon will be taken as rapidly as is practicable to the preselected site, with the first observer ensuring that the cord does not become tangled. The observer holding the radiosonde should be positioned downwind from the balloon so that it will pass directly overhead.

Correct positioning is the responsibility of the observer with the radiosonde since under these conditions the observer with the balloon will find it more difficult to change position. When the release area is reached, the observer holding the balloon will release the balloon and the instant the train slackens, the first observer will run downwind until the balloon takes up the slack. As this happens, the first observer will raise the radiosonde with one hand and bring the cord

forward in the other hand. If the movement of the hands is coordinated, the radiosonde will follow the balloon with no noticeable jerk.

When obstructions prevent the observer with the radiosonde from running downwind, the observer holding the radiosonde will stand in a position to observe the movement of the balloon. At the instant the balloon takes up the slack, the observer will follow through with the radiosonde to reduce the jolt and possible damage to the radiosonde.

#### 13.3.5 Thunderstorms: ***The radiosonde will not be launched into thunderstorms.***

Thunderstorms can degrade the radiosonde signal or force the balloon down causing early flight termination. In addition, a thunderstorm and its immediate surroundings are unrepresentative of the prevailing environment. Wait until the storm passes before doing a release. If the storm persists beyond the release window, no observation should be taken.

13.4 Delayed Release: The radiosonde should be released within the officially prescribed time limits. If a release is delayed beyond the time limit, careful consideration should be given to replacing the battery. If replacement is necessary, procedures shown in Chapter 8 of the MicroART and RRS Training Guide should be followed. These procedures will vary depending on when, during the pre-release sequence, the determination was made to replace the battery.

13.5 Operation of ART Remote Release Timer Switch: Follow the procedures described in Section 13.1, Items a-i. The purpose of doing a timed release is to allow one observer to launch a RDF radiosonde under routine conditions. Releasing the balloon and having the tracking equipment begin tracking at the proper time is essential in determining accurate heights. Observers not using the remote release timer may take several seconds to manually push the start switch. This time between balloon release and the time it takes to push the switch is lost data. The data recognized after the start switch is pressed may actually be several hundred feet above surface, but the tracking record will consider it as the first data received just above the surface.

The remote release switch is a timed device that emits tones for 1-minute prior to release. Ten seconds before the release, the switch activates a prolonged tone. Intermittent signals are heard until another prolonged tone indicates the automated release has been initiated. The observer should have released the balloon and instrument flight train with the last tone.

14. Maintaining Proper Signal Lock-On: The tracking antenna receives radiosonde radio signals in two distinct patterns, one associated with the main lobe and the other, the side lobes. If the Radiotheodolite system locks onto a side lobe instead of the main lobe, the position data are incorrect and tend to be very erratic with time. Wind data determined to be derived from side lobe tracing are in error and will be deleted. The RRS antenna may also lock-on a side lobe as well, but winds are derived from the GPS data transmitted from the radiosonde. It has nothing to do with the position of the RRS antenna. The only requirement is to have the TRS antenna receiving an acceptable signal.

At times owing to signal interference (i.e., noise), weak or fading signals, or faulty ground equipment, erratic angular data may result. This situation for the RDF tracking equipment is most prevalent when elevation angles are below 12 degrees, but can occur at other angles. This situation can cause a spike to appear in the data. Sudden, abrupt changes in the 6-second elevation or azimuth angles of the antenna are not realistic and are caused by signals too weak to supply the ground receiver with an adequate reference or by the lack of tracking sensitivity in the ground equipment.

Another type of erratic elevation angles with RDF tracking occurs when angles are greater than 12 degrees and at least 15 minutes of the observation have elapsed. In this case, erratic angles may be caused by equipment not operating properly, tracking a secondary lobe, or due to a signal loss. The result will be tracking errors in excess of predetermined tolerances in azimuth or elevation angles.

Poor ART Tracking may cause erratic angles or spikes in the data caused by noisy or weak signals or ground equipment problems, the data will be smoothed or removed in accordance with the procedures described in Chapters 9 and 11 of the MicroART Training Guide.

**MULTI-PATH PROPAGATION AND LIMITING ANGLES:** Multi-path propagation causes the ART antenna to stay in one position for a short time and recover when it gets an adequate signal. This will cause the antenna to bounce creating plots of the elevation angles with steps, or waves, on the plots. This situation is most prevalent when elevation angles below 12 degrees are encountered and becomes increasingly pronounced as the elevation angles near 6 degrees. If multi-path propagation is determined to be occurring, the anomalous data will be deleted.

The limiting angle is the elevation and azimuth angle of the RDF antenna at which the antenna cannot successfully track the radiosonde owing to multi-path propagation. Limiting angles are no less than 6 degrees off the horizon or obstructions (e.g., mountains or buildings) along the horizon. The MicroART software contains a station data file with the limiting angles for the site. Site personnel are responsible for ensuring the information is accurate. Whenever the elevation and azimuth angles are equal to or less than the limiting angles, the angular data is not used to calculate winds. Appendix J Section 3.2 provides information on how limiting angles are determined at each upper-air station.

The ART tracking system must be fully locked-on to the radiosonde transmitter's principal signal (e.g., not a side-lobe). This ideal state of signal reception is indicated by a lit Automatic Frequency Control (AFC) lamp on both the (MCU position #22 Figure E-1 page E-20) and the RCU (position #21, in Figure B-8 page B-12).

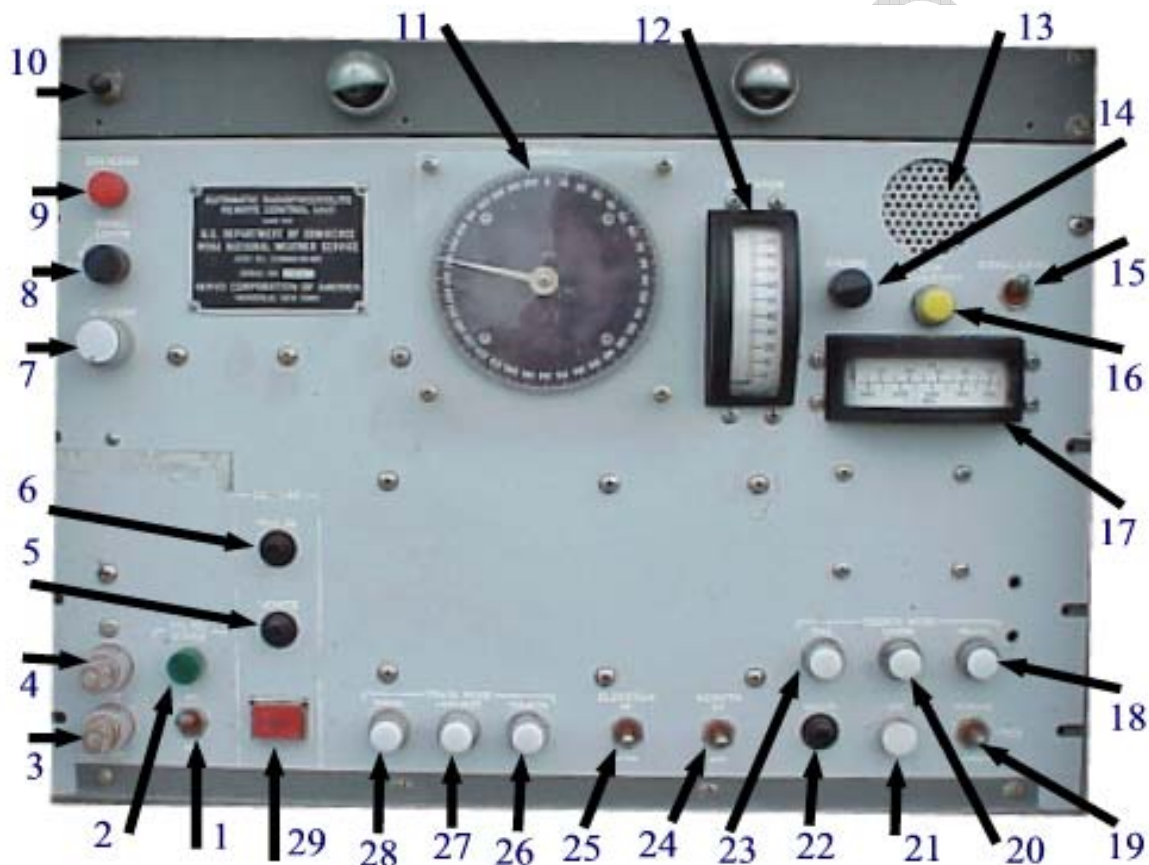


Figure E-1 - Open Remote Control Panel

## 15. Antenna Tracking Modes:

15.1 ART Antenna Tracking Modes: This section discusses the three tracking modes which may be used to steer the antenna to acquire the radiosondes transmitted signal.

**NEAR AUTO:** The ART system automatically and rapidly tracks the flight of the radiosonde.

**FAR AUTO:** The ART system automatically and slowly tracks the flight of the radiosonde.



**MANUAL:** The ART system permits the operator to override the automatic antenna tracking modes. This mode is typically used to lock on the radiosonde at release. It is especially helpful during strong low-level wind shear or when the radiosonde has tracked overhead. Separate controls allow the observer to manually steer the ART tracking antenna and control the antenna's rate of slew to the desired elevation and azimuth angles. To reacquire signal lock-on, the observer must be familiar with five control points on the Remote Control Unit (RCU) panel:

- a. **AZIMUTH INDICATOR:** This 4 inch circular dial and needle indicator displays the azimuth angle of the tracking antenna from 0 to 360 degrees in 1 degree increments (Indicator #11 in Figure E-1 page E-20).
- b. **ELEVATION INDICATOR:** This 4 inch vertical bar and needle indicator displays the elevation angle of the tracking antenna from -5 to +95 degrees in 1 degree increments (Indicator #12 in Figure E-1 page E-20).
- c. **AZIMUTH CONTROL SWITCH:** The observer can use this control in any Track Mode. This is a momentary switch that is routinely in the off position. When held in the clockwise (CW) position, the azimuth angle is increased. When held in the counter clockwise (CCW) position the antenna's azimuth angle is decreased (Indicator #24, in Figure E-1 page E-20).
- d. **ELEVATION CONTROL SWITCH:** The observer can use this control in any Track Mode. This is a momentary switch that is routinely in the off position. Push up the switch to increase antenna's elevation angle (Figure E-1 Indicator #25 page E-20).
- e. **SIGNAL STRENGTH AND FREQUENCY DISPLAY:** This 4 inch horizontal bar and needle indicator displays either one of two parameters. One parameter is the radiosonde frequency shown from 1655 MHz to 1705 MHz in 5 MHz increments. When the SIGNAL LEVEL/FREQ toggle switch (Indicator #15 on Figure E-1 page E-20) is set to SIGNAL LEVEL, this display reports the strength of the radiosondes transmitted signal in 10 dB increments, from 0 to 110 dB.

15.2 RRS Antenna Tracking Modes: There are three tracking modes that may be used with RRS. They are:

- a. **MANUAL:** Only moves the antenna through commands provided by the operator. These commands may be made by using the CDU or the Antenna Orientation/TRS Display and clicking on the "Slewing Arrows" when entering azimuth and elevation values in the azimuth and elevation windows and clicking the "Move Antenna" button.
- b. **AUTO:** Moves the antenna automatically either from the CDU or the Antenna Orientation/TRS Display. The operator, when using the CDU, should move the antenna close to where the instrument or balloon is sighted and first select

“Search”. The antenna will lock-on the strongest signal if the instrument is within the search “Cone Angle” and then go to “Auto”.

If the workstation is being used, the operator should move the antenna to the last azimuth and elevation value shown in the “Processed Data” and then move the cursor on the “Search” option and the antenna should find the strongest signal and then switch to the “Auto” Track Mode. The antenna should also go into “AFC” once it moves to “Auto” Track.

- c. **SEARCH:** This mode is used by the operator when using the CDU or workstation once the antenna is pointed to the approximate balloon position. The “Search” mode will only work if GPS is being received. If the instrument is not found, it will go to a “Full Search” routine that does a 360 degree search beginning at 90 degrees elevation and works gradually down at 5 degree increments until the instrument is found.

**Note:** The “Full Search” routine should be avoided unless the balloon is directly overhead.

### 15.3 Receiver Searching Modes:

#### 15.3.1 ART Receiver Search Modes:

15.3.1.1 Limited Search Mode: When the Limited Search button is pressed or the signal is lost, the ART receiver is placed into a limited search. Typically in the range of +/-5 MHz about 1680 MHz or about the last viable frequency that was being tracked. When the signal is found and the signal is strong enough, automatic lock is acquired and the AFC lamp should light.

15.3.1.2 Full Search Mode: When the “INITIATE” button is pressed or the signal is lost, (See position #23 on Figure E-1 page E-20) a full search will not be initiated until after a limited search has been completed. In full search, the ART receiver goes into a full sweep of the 1655 to 1705 MHz band. The indicator lamp lights up. The time required to locate an instrument using “Full Search” may take as long as 40 seconds.

**Note:** Usually the need to go into full search should not occur unless a large frequency jump has occurred due to jarring of the instrument at release. Another cause is antenna-loading. This occurs when the observer places the instrument on the ground prior to release. Placing the instrument on the ground causes the frequency to jump or increase. The frequency will drop suddenly when the instrument is lifted off the ground. This sudden frequency change creates a signal loss and causes the antenna to go into the search mode. The period of time it takes the signal to be reacquired is dependent on the amount of frequency change.

15.3.1.3 Manual Search Mode: When the button is depressed (position #18, on Figure E-1 page E-20), the ART system’s receiver is disengaged from an automatic search mode (e.g., limited or full search).

If a radiosonde side-lobe signal has been tracked, intermittent signal drop-out may occur and at Sippican (VIZ) sites MicroART will assigned low quality values (Q values) for the received signal. If this occurs, then the tracking antenna and/or the receiver's automatic modes may need to be manually disengaged and manually repositioned using the clinometer and the wind rose if the instrument is visible or use the information provided from the upper wind charts and Velocity Azimuth Display (VAD) wind profile off the Weather Service Radar (WSR-88D) console.

The following indicators and controls need to be monitored and/or operated to affect a sweep or search of radio frequencies in the 1655-1705 MHz band:

- a. **FREQUENCY INCREASE/DECREASE Switch:** This toggle switch is usually off. When pushed and held in the INCREASE position, receiver frequency is increased. When it's pushed and held in the DECREASE position, receiver frequency is decreased (This is position #19 in Figure E-1 page E-20).
- b. **SIGNAL/FREQUENCY Meter:** The operator needs to closely monitor this meter in order to determine the occurrence of strongest signal strength as a function of the manually input receiver frequency.
- c. **LOW SENSITIVITY Indicator Switch:** When either the Remote Control Unit or the Master Control Unit is first powered on, the system is designed to automatically lower the receiver's sensitivity. This low sensitivity state is indicated by the yellow lamp (position #16 in Figure E-1 page E-20) being lit. Press this button to toggle the switch to high sensitivity (the lamp goes dark).

15.3.2 RRS Receiver Search Modes: Searching to find the radiosondes frequency may be accomplished from the CDU or at the RRS workstation using the "Antenna Orientation/TRS Display".

15.3.2.1 Manual Search Mode: Using the CDU to manually find the radiosondes frequency or set the frequencies may be accomplished using a couple of different techniques.

Steps to manually move the frequency using the CDU:

Method 1:

- a. Press the "REC" key, a menu will appear and select "4: Tune" key (See Figures E-2 and E-3 page E-24)
- b. Use the Up and Down arrows on the CDU to move the frequency in the desired direction. Using the "O/fast" key will allow the frequency change more rapidly if a large frequency change is required. Monitoring the value to the right of "SIG" on the display window will provide a direct display when the radiosonde signal is found.

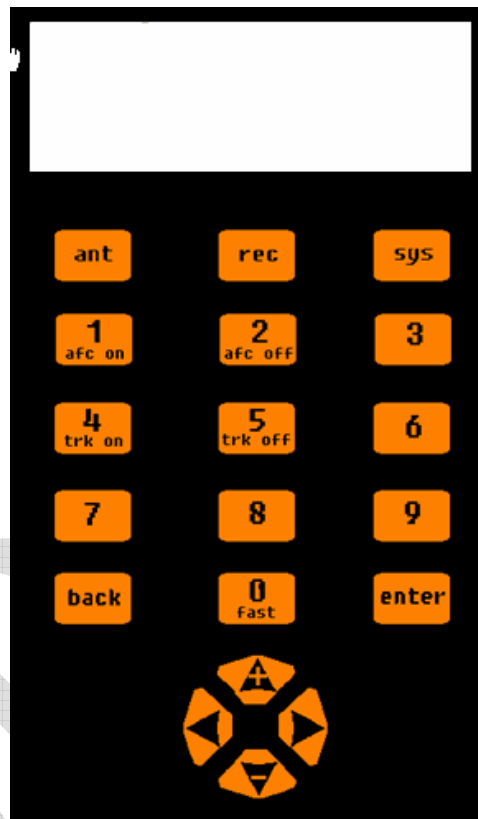


Figure E-2 – Console Display Unit (CDU)

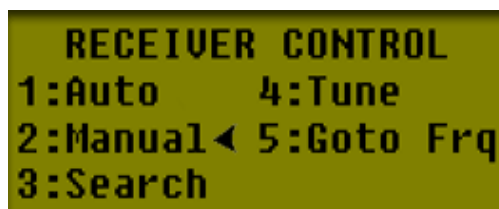


Figure E-3 – Receiver Display

## Method 2:

- a. Press the “REC” key, a menu will appear and select “5: Goto Frq” key (See Figures E-2 and E-3 page E-24).
- b. Use the Up and Down arrows on the CDU to move the frequency in the desired direction. Using the “O/fast” key will allow the frequency to change more rapidly if a large frequency change is required. Monitoring the value to the right of “SIG” on the display window will provide a direct display when the radiosonde signal is found.

Using the RRS workstation, with the “Antenna Orientation/TRS Display” the frequency may be manually set or moved manually to locate the radiosondes frequency. The receiver has an operating band from 1668.4 MHz to 1700.0 MHz. The NWS is authorized only to operate from 1675 MHz to 1690 MHz.

15.3.2.2 Auto Search Mode: The easiest method to have the receiver automatically find the signal is to:

- a. Press the “REC” key, a menu will appear and press the “3: Search” key (See Figures E-2 and E-3 page E-24).
- b. Two screens will appear. The first screen shows the (lower) frequency of the search. The value entered here is stored for recall as the initial value for this entry screen the next time that a frequency search is requested. Press the “Enter” key to proceed.
- c. The second screen that appears is the (upper) frequency of the search. These are defaults that are set to the limits of the receiver. (1668.4 MHz and 1700 MHz) Sites may change the limits to those the NWS is authorized to operate within 1675 MHz to 1690 MHz. If the upper limit looks fine, go ahead and press the “Enter” key.
- d. A search will initiate. When the search begins, the AFC is turned off, a screen shows the current frequency and signal strength numerically and graphically. Press the “Enter” key when the radiosondes signal is located. The receiver holds the last frequency and the CDU will revert back to the idle State. If the receiver is not in AFC, go ahead and press the “1: AFC On” key.

## 16. Successful Release Criteria:

16.1 MicroART Flight: A successful radiosonde release will be verified by the MicroART software when examining the first few minutes of data of the observation. A successful radiosonde release is based on the following criteria:

- a. The pressure must decrease for 2.8 of the first 3.0 minutes.
- b. Temperature must be present for at least 1.0 minutes of the first 5.0 minutes of the flight.

All of the above must be satisfied. If these requirements are met, the launch is considered successful and the observation continues. If they are not met the observation will be considered unsuccessful, the observation will be terminated. Once authorization for a second release is obtained, preparations for another release should get underway immediately.

#### 16.2 RRS Flight:

A successful radiosonde release will be verified by the RRS software when examining the first few minutes of data of the observation. A successful radiosonde release is based on the following criteria:

- a. The pressure must decrease for 2.8 of the first 3.0 minutes.
- b. Temperature must be present for at least 1.0 minutes of the first 5.0 minutes of the flight.
- c. Temperature or pressure can not be missing for 3.0 or more consecutive minutes.

All of the above must be satisfied. If these requirements are met, the launch is considered successful and the observation continues. If they are not met, the observation should be considered unsuccessful and the observation terminated. When authorization for a second release is obtained, preparations for another release should get underway immediately.

#### 17. Multiple Releases:

17.1 The Second Release: Each upper air station should track the radiosonde to the highest altitude possible. Care must be taken to ensure the observer checks and verifies the data is realistic and reasonable. Software checks and call-ups should be investigated and unrealistic data edited or eliminated prior to message transmission. If a radiosonde terminates before reaching 400 hPa, a second release may be required. When necessary, the second radiosonde should be released as promptly as possible in order to stay within the time limits of the scheduled observation (see “Delayed Release” Section 13.4 page E-18, for procedures). However, if because of unfavorable atmospheric conditions or other reasons, it is apparent that a pressure equal to or less than 400 hPa cannot be attained in subsequent attempts, an additional release should not be made.

If a second release is not made and the record from the first one is usable, even though it did not extend to a pressure equal to or less than 400 hPa, the record from the first release should be evaluated and used for summary and transmission purposes.

When a second release is required but not made, the reasons for the omission should be stated fully in the “Remarks” section of the WS Form B-29, Rawinsonde Report. If a second and succeeding release does not reach the required minimum altitude, the ascension providing the greatest amount of data should be the official observation.

**17.2 The Third Release:** If flight equipment or ground equipment fails on the second release and results in the premature termination of the observation, a third release may be initiated if authorization is granted. The third release however, marks the limit for the number of attempts to complete a scheduled synoptic observation. No further attempts will be made if the third release fails to meet the successful observation criteria. If this release attempt fails, data from the single most complete observation should be disseminated unless missing temperature data exceeded the tolerances specified in Table E-3 page E-28 for all release attempts. In this case, a missing observation should be reported.

**18. Observation Success:** In order for an observation to be successful, all criteria for a successful release (see Section 16,) must first be met to satisfy the MicroART and RRS software. The observation is finally deemed successful when the upper air sounding contains at least the required amount of data per three strata and must not have had more than 6 minutes of missing data from surface through 400 hPa. If the observation was not terminated for the reasons specified in Table E-3 page E-28 and has not failed, the observation is deemed successful.

If a radiosonde observation has to be terminated early (see reason for early termination in Appendix G) initiate procedures described in Appendix D (Pre-Flight Preparations) to prepare a second flight. This makeup flight is also known as the ‘second release’ and will acquire data for the same synoptic reporting hour as the first flight.

To distinguish among multiple flights launched to obtain a given site’s synoptic observation, MicroART requires a release number (e.g., 1, 2, or 3) to be entered. NOTE: A release number of 0 may be entered for test flights. A range error (release number greater than 3) warning should be displayed, but may be overridden by the observer. The RRS software automatically assigns a release number 1 to flights having an unused ascent number. If the flight should terminate prior to being successful or terminated by the observer, the software will prompt if another release is desired and mark the next release with the appropriate release number in the data file.

An observation is deemed successful when reliable data from the surface to at least the 400 hPa level has been recorded. Sites using Sippican (VIZ) instruments receive meteorological data with quality values (Q-values). Site using the Sippican RDF radiosondes, the Q-values of 30 or more are valid. Data with Q-values less than 30 are invalid or unreliable and the software will mark them missing. Sites using the Sippican GPS radiosondes the Q-values are 100 if received and 0 if missing. The maximum permissible quantity of missing temperature data is provided in Table E-3 page E-28.

An observation should be terminated when the number of minutes of missing temperature data, as given in Table E-3 page E-28, are exceeded. Table E-3 page E-28 represents the maximum tolerable amount of missing data, expressed in both strata thickness and time interval.

**NOTE:** Observers should be aware that the MicroART and RRS software will only terminate the flight for data the software deems missing. Additional data that the observer deletes will not be taken into consideration by the software program. The observer is responsible to ensure that the criteria in Table E-3 are not exceeded.

Pressure Range (hPa)	Strata Thickness (km)	Minutes of Missing Data (minutes)
Surface to 700	1	4
Surface to 400	2	6, with above criteria satisfied
Surface to 100	3	12, with above criteria satisfied
Surface to termination	5 (Upper < 100 hPa)	16, with above criteria satisfied

Table E-3 Termination Due to Missing Temperature Data

**Note:** Table assumes a standard ascent rate of 300 meters per minute.

19. Reasons for Missing Data:

19.1 Weak Signal: Weak or fading signals can result from a weak battery, a radiosonde moving too far away, or a ground tracking antenna that is not correctly locking onto the radiosonde signal.

19.2 Interference: Signal interference has become a problem especially at sites located near large metropolitan areas. Abrupt change in the audio or frequency is a good indicator of possible interference. Signal interference with the GPS radiosonde is less of a problem due to a signal that usually does not drift more than  $\pm .1$  MHz during a flight and the signal is less than 350 KHz in width.

19.3 Sensor Failure: Radiosonde sensors may fail. If the relative humidity sensor fails the flight can be continued if the relative humidity is not considered critical. If the temperature or pressure sensor fails, the flight will be terminated at the last reliable data point.

19.4 Other Causes: In the event that the quality of the telemetered data becomes questionable and the criteria covered in Section 19 are not met, the ascent may be terminated.

19.5 Successful Observation - Some Missing Data: Whenever a stratum of missing temperature data is followed by a satisfactory record, the computations should be continued provided the stratum or strata of missing data does not exceed the limits in Table E-3, for “Surface to 700 hPa” and “Surface to 400 hPa”. When the limits are exceeded in one stratum of missing temperature data, the computations should be terminated at the base of the stratum.



19.6 Unsuccessful Observation - Sum of All Missing Data: Whenever the limits for “Surface to 700 hPa” or “Surface to 400 hPa” in Table E-3 are exceeded, the observation should be terminated at the base of the stratum in which the limits are exceeded.

20. Multiple Releases: Sites that have a failed release must decide if they have a local requirement for another release. This decision should be made by the senior meteorologist on-duty. If a site does not have a meteorological need for the data, they must then call the Senior Duty Meteorologist (SDM) at National Centers for Environmental Prediction (NCEP) and inquire if they need another release. Under no circumstances, will a station attempt more than 3 releases to obtain a successful flight.

21. Unscheduled Observations: Unscheduled or special observations are those performed outside the standard times of scheduled synoptic observations (see Section 2 page E-3, Scheduled Synoptic Times). Special observations may be requested by either NCEP (e.g., Storm Prediction Center), or in support of special projects authorized by WSH or Regional Headquarters. Each NWS upper-air site will adhere to all the basic requirements for synoptic observations except for cases of severe weather, equipment limitation, or other factors that warrant early termination. Special observations will be transmitted and archived in the same manner as scheduled synoptic observations.

**APPENDIX F – IN FLIGHT PROCEDURES AND DATA TRANSMISSION**

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1. **Introduction:** After a successful balloon flight train release the observer will follow procedures to ensure a successful flight and timely dissemination of the upper-air data. This appendix and either the MicroART Training Guide or the RRS User's Guide provide observers

with the correct procedures.

## 2. Checking Signal Strength and Lock-on:

2.1 MicroART and MCU checks: After return from the balloon release point, the observer should check the MCU readings and MicroART computer displays. If the signal strength is strong and the observer is confident the antenna is locked on the main signal, the position data should be checked to determine when lock-on occurred. The observer should keep the audio turned up loud enough to monitor the instruments tones and check for interference or signal loss.

2.2 RRS CDU and Workstation Checks: The observer must prior to release and after release, verify the frequency and signal strength by using the Console Display Unit (CDU). The check prior to and after release with the CDU allows the operator the opportunity to reacquire the frequency or signal if lost. If the CDU is inoperative or the weather is inclement, the observer may have to wait until returning to the office to use the workstation to ensure the system is tracking effectively. The observer should utilize the status bar and Antenna Orientation/TRS Display on the workstation to verify equipment tracking and the signal strength after returning to the office.

2.3 Tracking Problems: Rapid loss of signal strength or quality, major fluctuation in angular readings, or shift in frequency should be looked at closely.

- a. Turning up the audio with the ART tracking system will allow the observer to monitor the signal quality and tones essential for the early portion of the flight where the chance of getting on a side lobe or another signal is most likely.
- b. The RRS has an audible alarm if data goes missing for 1 minute and will alarm again at 2 minutes.

If it is apparent that a significant change has occurred and the antenna is not tracking on the signal, the observer should take immediate action by checking the antenna position and signal strength. Depending on the observer's analysis, either the antenna or the frequency will have to be adjusted.

2.3.1 Signal Problems: If the signal strength drops with the tracking system, initiate "Search" with RRS by pressing the "Scan" button. If the signal can not be found, press the "Manual Tracking" button and move the antenna to the probable direction by noting the previous tracking prior to signal loss. This may be accomplished by going to the Processed Data and looking at the last good azimuth and elevation data points. Also keep in mind the wind flow in the atmosphere. This may be accomplished by looking at the current WSR-88D wind profile or looking at the upper-level charts. RRS allows the operator to click the "Search" button to relocate the radiosonde. If GPS is being received, the "Search" button should point the antenna to the last known GPS location. If no GPS is received, the observer should move the antenna to the last known position or use the upper level charts to move the antenna then, click on the "Search" button in the TRS/Antenna Display.

**2.3.2 Frequency Problems:** If the frequency has made an abrupt shift or significant change since the release, determine if the signal being received is the radiosonde. ART sites should turn up the speaker volume and listen for the instrument tones. If the signal is not from the instrument, the observer should immediately press the “Manual Search” button and toggle the frequency down in the direction where the signal was originally, stopping once the signal is acquired and pressing the “AFC” button to have the equipment automatically begin tracking the signal. If the signal should again track off the instrument’s frequency, it may become necessary to leave the tracking in a “Manual Search” until the other signal no longer interferes with signal acquisition.

Sites using GPS radiosondes and the RRS tracking system should have fewer problems with frequency shifts and interference. Drift for the transmitter is less than .2 MHz during the flight and interference is limited due to the narrow bandwidth. If the signal is lost, the operator may locate the frequency by using the “Scan” button on the Antenna Orientation/TRS Display window or change the frequency manually by clicking on the up or down arrows or clicking on the “Set” button and typing in the frequency desired.

If an abrupt shift or change in the frequency of the instrument is noticed, the observer must determine that the signal being received is from the radiosonde. The observer should then determine that the signal being tracked is from the main lobe and not from a side lobe. This can be determined by looking at the signal strength and listening to the signal’s audio output if tracking with the ART tracking system. If the signal is weak or scratchy, the observer may want to go into “Manual Tracking” and adjust the elevation and azimuth manually to ensure the signal is the main signal.

If there has been an unexplained shift, the observer should write down the time that it occurred and continue to monitor the flight by keeping the audio turned up. This information should be communicated to the Regional Upper-Air Program Manager for help in determining possible problems with radiosonde production lots. The observer should also pass along the radiosonde serial number and the shipment number.

## **2.4 Routine Checks:**

**2.4.1 MicroART Check:** MicroART will prompt the observer to enter the time the ART equipment locked on the radiosonde after release. Chapter 9 of the MicroART Training Guide provides instructions on how to properly determine the correct time. The standard procedure would be to enter 0.0 minutes and then look at the positional data to determine when lock-on occurred. If there are no problems, follow the procedures in the MicroART Training guide for processing and handling of the data. During the flight, periodically (at least every 15 minutes) check the MicroART computer displays for problems.

If there are data problems, MicroART will typically provide alerts along with flight status messages and/or a red flashing “LOS” (Loss of Signal) display. Chapters 9 and 14 of the MicroART training guide show the types of data problems that may be encountered and the procedures for checking and editing the upper-air data. If the LOS alert persists, check the MCU readings to help determine the cause.

**2.4.2 RRS Check:** The RRS software determines the release by a pressure change algorithm. Positional data is determined by the GPS lock and not where the Telemetry Receiving Antenna is pointing. If GPS data is being received the Processed Data will provide the azimuth and elevation of the radiosonde. It should be remembered that the processed data may lag from the real-time data by 2 minutes or more.

## **2.5 Flight Check Parameters:**

### **2.5.1 MCU Check for the ART System:**

At the MCU panel, check the following:

- a. Signal strength - Within 5 minutes after release, the signal strength should typically be above 60 db. If not, refer to Section 2.3.1 page F-2.
- b. Received frequency - The AFC should be set to Auto and the received frequency should be within 5 MHz of what it was during baseline. If the frequency has shifted, refer to Section 2.3.2 page F-3.
- c. Audio signal - Should sound clear without noise. If it's weak or noisy, refer to Section 2.3.1 page F-2.
- d. ART tracking motors - Tracking motors must be off Stand-By mode and the angular data display must be showing changing angular values.
- e. Elevation angles - If angles exceed 80 degrees, follow the procedures in Section 4 page F-6 for handling overhead balloon flight conditions.
- f. Tracking mode - Should be set to the Near Auto mode. After about 15 minutes into the flight, set the tracking mode to Far Auto. However, if the flight train is overhead leave the tracking in Near Auto until the elevation angle drops below 60 degrees.
- g. Low Sensitivity switch - Should be turned off, unless the flight train is overhead. See Section 4 page F-6 for handling overhead balloon cases.

If there are no problems, continue to the procedures in the MicroART Training guide for processing and handling of the data. During the flight, periodically (at least every 15 minutes) check the MCU readings for problems.

### **2.5.2 RRS Workstation Checks:** At the RRS workstation check the following:

- a. Signal strength - Within 5 minutes after release, the signal strength should typically be above 50 db. If not, refer to Section 2.3.1 page F-2.

- b. Received frequency - The AFC should be set to Auto and the received frequency should be within .2 MHz of what it was during baseline. If the frequency has shifted, refer to Section 2.3.2 page F-3.
- c. RRS tracking motors - Tracking motors must be in Auto mode and the angular data display in the Processed Data must be showing changing angular values.
- d. Azimuth and Elevation angles - If not locked-on and if GPS is received, click on the "Search button. If no GPS, move the antenna to approximate direction and azimuth and Click the "Search" button.
- e. Tracking mode - Should be set to the Auto mode.

If there are no problems, follow the procedures in the RRS Users Guide for processing and handling of the data. During the flight, periodically (at least every 15 minutes), check the workstation for problems.

3. Corrective Actions: If the signal strength is weak or noisy, or there is a major shift in the radiosondes frequency, there is either a problem with the radiosonde or ground equipment. Sometimes these problems will go away as the flight progresses or they get worse possibly resulting in the termination of the flight due to missing or bad data. If the observer notices these or similar problems check the following:

- a. Make sure the ART equipment is not tracking a "side lobe" Chapter 14 of the MicroART Training Guide provides procedures for identifying side lobe tracking. If it is determined side lobe tracking is occurring, set the tracking mode to manual. Gradually adjust the elevation and azimuth angles until a significant increase in signal strength occurs. Reset the tracking mode to Near or Far Auto and follow the procedures in Chapter 14 of the MicroART Training Guide for editing the angular data.
- b. Check the elevation angle. If it is over 80 degrees follow the procedures in Section 4 page F-6.
- c. Check the radiosonde frequency. If the frequency shift becomes so severe that the ART Automatic Frequency Control (AFC) can not find or track the radiosonde signal, try setting the AFC to Manual and sweep the frequency until it locks onto the radiosonde. Reset the AFC to Auto.
- d. Closely monitor the flight data until the flight train reaches at least 400 hPa. If the problems cause the flight to terminate before this level, follow the procedures for making a second release (Section 6 page F-8).
- e. If problems persist from one flight to the next, there may be problems with the ground equipment or the way the radiosonde is prepared and/or how the flight

train is released (e.g., rapid shift in frequency may be a result of a poorly prepared/handled radiosonde).

If it is determined that the observer's actions are not a cause for the problems, the station Electronics Technician should check the equipment.

4. Balloon Overhead: Depending on the system, different methods can be used:
  - a. ART - In a situation where the balloon will likely go overhead with the ART tracking equipment, the observer should press the "Near Auto" switch. This will allow the equipment to track the balloon as it makes angular changes more rapidly. The observer should closely monitor the elevation and azimuth angles. If the balloon is going overhead, the operator should press the "Manual Search" indicator and manually position the antenna using the past observed movements to determine the trend and which direction the instrument is tracking. This condition may require some delicate adjustment, but once the signal strength is regained go back into "Near Auto" tracking. Continue using "Near Auto" tracking until the elevation angles decrease to less than 60 degrees.
  - b. RRS- When using the RRS tracking equipment, overhead conditions or rapidly changing elevation or azimuth angles may cause the antenna motor current to increase and generate a TRS Status message if the conditions exists for more than four seconds. The tracking will be suspended for eight seconds. The Status Message that comes up for the TRS is the MCU: 0x0800 error. When a MCU error message is received, the operator should verify the antenna position and movement. If the antenna is moving rapidly or at high elevation angles, place the antenna in Manual tracking until the azimuth and elevation angles shown in the Processed Data decrease in elevation or show less movement.
5. Failed Flight: On occasion, a flight will terminate before reaching 400 hPa. This is deemed a failed flight because insufficient data was collected. MicroART and RRS may automatically terminate the flight early or the observer may terminate the flight manually for a number of reasons. Appendix G of this manual and Chapter 11 of the MicroART and RRS Training Guide provide reasons for flight termination.

Flights are deemed a failure if one or more of the following occurs:

- a. The balloon fails before reaching 400 hPa.
- b. The amount of missing temperature data exceeds 4 minutes between surface and 700 hPa and 6 minutes from surface and 400 hPa.
- c. The quality and accuracy of the pressure and/or temperature data are deemed poor either automatically by the software or by the observer.

Before proceeding with a second or third release do the following:

- a. Do not attempt a release if the problem (e.g., ground equipment failure, inclement weather) that caused the flight failure cannot be corrected or mitigated before the next release is made.
- b. Ask the lead forecaster if another release is required. If the site does not have a requirement, the Lead Forecaster (LF) must contact the Senior Duty Meteorologist (SDM) at NCEP and let him/her know. If the SDM believes another release is required for national purposes, the LF should authorize the release. If a second release is not required, follow the procedures for terminating a flight in Appendix G of this handbook, Chapter 15 of the MicroART Training Guide, and Chapter 11 of the RRS User Guide...

5.1 No Release Made or Second Release Denied or Unsuccessful:

5.2 No Data above Surface Available: If a flight fails at release and no data above surface is available, the observer should manually code the TTAA, TTBB, TTDD messages. The TTCC message does not need to be sent. Allowing MicroART to automatically code the data will cause improper messages to be sent out with ///// for all met and wind data. These messages cause problems at NCEP and can corrupt the numerical prediction models.

The RRS software will code a “No Data Message”.

(See examples of manually coded messages below)

**AWIPS Message:** USUS41 KLWX 250000  
MANIAD  
72403 TTAA 7500/ 72403 51515 10142=

**Alaska Message:** UMAK48 PAFC 250000  
SGLAFC  
70273 TTBB 7500/ 70273 51515 10145=

**Pacific Message:** /C UJHW2 PHTO 250000  
91285 TTDD 7500/ 91285 51515 10144=

\* Pacific and Alaska Region may be using a slightly different header format or change the header format at a later date. Sites should check with the Region Upper-Air Program Manager or the Regional Communication Manager for format questions.

**NOTE: There are two different procedures to follow when a flight is missed.**

- a. When a flight is not possible for any reason (MicroART) - The observer should manually code the messages using the proper 101 group which signifies the reason for no data. RRS has a “No Data” Option under the “Messages” dropdown.



- b. When a flight is missed and another was possible, but not authorized - The observer should add a 10148 group after the 51515 message to the TTAA, TTBB and TTDD messages. The 10148 group signifies that an ascent was not authorized. The 10148 group should only be used when a second release is possible, but not allowed by NCEP or other approving authorities.

5.3 Data above Surface Available: If a release or multiple releases were made and some data above surface was acquired and considered accurate, the observer should transmit the data from the flight containing the greatest amount of reliable data. If the observer attempts another release, but it fails, and the initial flight data will be transmitted, the observer should go to the ‘ART Options’ Menu and select ‘Resume’ using the log diskette from the initial flight. When the data has been transmitted the flight will be given an ascent number and the data should be archived.

RRS allows the operator to select another release if a flight does not reach 400 hPa. It will save the initial flight data and can be used if the subsequent releases are not allowed, fail or have less data.

A successful flight usually requires an ascent to 400 hPa, however if upper-air data above the surface is obtained and a second release is not possible or authorized the data acquired should be used. The flight must be assigned an ascent number and archived if the data is transmitted.

6. Second Releases: If a second release is authorized, observers will do the following:

a. **MicroART:**

- 1). Terminate the sounding by pressing the red Stop Print button on the MCU.
- 2). Follow the procedures in Chapters 15 of the MicroART Training Guide.
- 3). Follow the procedures in Appendices I and N of this manual.
- 4). While preparing the next radiosonde release, tune the frequency at least 5 MHz away from the frequency of the previous radiosonde. This applies if the previous radiosonde is still airborne and transmitting a signal.
- 5). If the second release fails, follow the instructions in Section 5 if no additional release is authorized...

b. **RRS:**

- 1). Terminate the sounding using the “Flight” Option if the software has not terminated the flight.
- 2). When asked “Do You Wish to Do Another Release” click the “Yes” button.

3). Follow the procedures in Chapter 8 of the RRS User Guide.

7. Data Checks: High quality upper-air observations are critical for NWS operations. None of the NWS Upper-Air ground Systems now and into the foreseeable future are expected to eliminate the observer's requirement to edit and correct data. **All observers will be proficient in determining data accuracy.** The software provides status messages, checks and alerts to the observer of flagged errors or potential problems. The observer should pay attention to these notices and check the data that has been flagged or identified as having possible problems or inconsistencies. **Checking the quality and plausibility then, editing the upper-air data, are an essential part of the duties of an upper-air observer.** The observer must make every effort to identify and edit erroneous data before it is disseminated. NCEP and NCDC data quality control systems will not detect all data errors.

Chapters 9 and 14 of the MicroART Training Guide and Chapters 9 and 13 of the RRS User Guide provide procedures for identifying and editing data errors. The software does not automatically edit or delete erroneous data. It only alerts the observer to questionable or erroneous data. The observer must review and edit data before it is disseminated. Remember, the observer is responsible for the accuracy and timeliness of the observation.

8. Transmission of Observations: Once the observer has checked the quality of the data, follow Chapter 10 of the MicroART and RRS User Guide for transmitting the coded messages. These data will be transmitted through the telecommunication system in as timely a manner as possible. Failure to transmit the observation on time will result in the data not being ingested into one or all of the numerical weather prediction models. The deadlines for transmitting the coded messages are shown in Table F-1.

H is the time at either 00:00 or 12:00 UTC

Part A:	H + 30 minutes
Part B:	H + 30 minutes
Parts C:	H + 120 minutes

Table F-1 Deadlines for Transmitting Upper-air Data

On a typical flight lasting 100 minutes, the Part A and B messages are ready for transmission at about H + 15 minutes and the Part C and D messages are ready at about H + 40 minutes. If the observer has other office duties to perform away from the MicroART computer, the data should be checked and transmitted at the above times.

If time is short owing to a delayed release or second/third release, at a minimum check and transmit Part A and Part B messages as soon as possible.

9. Coded Messages: The observer must understand how to properly code and decode upper-air messages. The messages for the sites in the continental United States, Alaska, the Bahamas, and the Caribbean are in WMO Region IV. The sites in the Pacific Region are in WMO Region V. The coding practices differ slightly in Region IV and V, the difference being

the stability index and mean low level winds are not computed for sites in Region V. Coding at ART sites will show this difference. It has been determined to code using Region IV practices for all RRS sites.

### CODED MESSAGE BREAKDOWN

91285 TTAA 56001 91285 99011 28060 01009 00107 24856 01007  
 92787 20456 33502 85514 18265 22504 70145 07413 27011 50586  
 04170 33025 40758 17367 32025 30966 32764 30537 25092 40762  
 30545 20241 52560 30541 15421 67158 30024 10657 79756 32024  
 88999 77999 51515 10164 00011 10194 32003 23507=

IIiii TTAA YYGGI<sub>d</sub> IIiii 99PPP TTTDD dffff 00hhh TTTDD dffff  
 92hhh TTTDD dffff 85hhh TTTDD dffff 70hhh TTTDD dffff 50hhh  
 TTTDD dffff 40hhh TTTDD dffff 30hhh TTTDD dffff 25hhh TTTDD  
 dffff 20hhh TTTDD dffff 15hhh TTTDD dffff 10hhh TTTDD dffff  
 88PPP 77PPP 51515 10164 000I<sub>s</sub>I<sub>s</sub> 10194 dffff dffff=

IIiii - Block number and station number

TTAA - Indicator of mandatory levels up to 100 hPa.

YYGGI<sub>d</sub> -

YY - Day of the month, (When winds are given in knots 50 will be added to YY)

GG - Actual time of observation, to the nearest whole hour UTC

I<sub>d</sub> - Indicator used to specify the pressure relative to the last standard isobaric surface for which a wind is reported. Reported to the nearest hundreds of hectopascals. (Used in TTAA and TTCC)

PPhhh - Mandatory pressure levels

PP - Starts with 99 - indicating surface 00 -1000 hPa 92- 925 hPa 85 - 850 hPa on until 10 - 100 hPa.

hhh - Height in geopotential meters (gpm)

Sfc to 500 hPa - Reported in whole gpm (thousands not reported) 3204 gpm reported 204  
 500 hPa to Term - Reported in tens of gpm 6053 gpm reported 605

TTTDD - Temperature and Dewpoint Depression Values

TTT - Dry bulb temperature in degrees Celsius. Last digit indicates if the temperature is negative or positive. Negative temperatures will have an odd number for the 3rd digit. Positive

temperatures will have an even number for the last digit.

DD - Dewpoint depression - This number is subtracted from the dry bulb temperature. Numbers of less than 55 are degrees and tenths. (i.e) 49 is 4.9 degree dewpoint depression. Numbers of 56 or greater are dewpoint depressions in whole degrees. To obtain the proper dewpoint depression value subtract 50 from values 56 or greater. (i.e) 72 would be a dewpoint depression of 22 degrees.

ddfff - Wind Direction and Speed

dd - True wind direction to the nearest 10 degrees. Wind directions of 500 degrees or greater indicate winds with speeds greater than 100 knots. When reading the direction in this case, one should subtract 500 from the direction and remember to add 100 to the wind speed value.

fff - Wind speed in knots. Wind directions are actually rounded to the nearest 5 degrees. The unit digit of the wind direction is added to the hundreds digit of the wind speed. (i.e., 27520 is the wind from 275 degrees at 20 knots.)

88hhh - TTTDD 88 - indicates tropopause  
77hhh - dffff 77 - indicates max wind group

51515 - Regional Code Groups Follow

10164 - Indicator for the stability index that follows

10194 - Indicator that the mean low level wind groups follow

ddfff dffff - First group mean winds sfc - 5000 feet  
Second group mean winds 5000 - 10000 feet

= (End of message symbol) It is a telecommunications character and is not part of the code.

91285 TTBB 56000 91285 00011 28060 11008 26057 22000 24856  
33905 19057 44850 18265 55795 13257 66768 12260 77764 12039  
88700 07413 99679 05817 11675 06259 22670 06661 33652 06061  
44644 05666 55627 03462 66606 02068 77567 01163 88548 01271  
99478 05769 11339 28364 22281 34763 33137 71358 44100 79756  
31313 01102 82307 41414 59571=

IIiii TTBB YYGGa4 IIiii 00PPP TTTDD 11PPP TTTDD 22PPP TTTDD  
33PPP TTTDD 44PPP TTTDD 55PPP TTTDD 66PPP TTTDD 77PPP TTTDD  
88PPP TTTDD 99PPP TTTDD 11PPP TTTDD 22PPP TTTDD 33PPP TTTDD  
44PPP TTTDD 55PPP TTTDD 66PPP TTTDD 77PPP TTTDD 88PPP TTTDD  
99PPP TTTDD 11PPP TTTDD 22PPP TTTDD 33PPP TTTDD 44PPP TTTDD  
31313 s<sub>r</sub> r<sub>a</sub>r<sub>a</sub> s<sub>a</sub>s<sub>a</sub> 8GGgg 41414 N<sub>h</sub>C<sub>L</sub>hC<sub>M</sub>C<sub>H</sub>=

a<sub>4</sub> - Type of measuring equipment used. (Used only in TTBB.)

0 - Pressure instrument associated with wind-measuring equipment

1 - Optical Theodolite

2 - Radiotheodolite

3 - Radar

4 - Pressure instrument associated with wind-measuring equipment but pressure element failed during ascent

5 - VLF-Omega

6 - Loran-C

7 - Wind profiler

8 - Satellite navigation

9 - Reserved

**Note:** a<sub>4</sub> is not fully implemented into the MicroART software - MicroART codes "0" in TTBB & TTDD.

PPP - Pressure of Significant Levels Selected

SFC to 100 hPa - Levels selected to nearest whole hPa

Above 100 hPa - Levels selected to nearest 0.1 hPa

31313 - Data on Sea Surface Temp & Sounding System Used

s<sub>r</sub> - Solar and infrared radiation correction.

0 - No correction

1 - Correction Made

r<sub>a</sub>r<sub>a</sub> - Radiosonde Used

87 - Sippican GPS Mark IIA (USA)

51 - Sippican type B-2 time commutated (USA)

52 - Vaisala RS80-57 (Finland)

s<sub>a</sub>s<sub>a</sub> - Tracking Technique/Status Used

00 - No wind finding

01 - Automatic with auxiliary optical direction finding

02 - Automatic with auxiliary radio direction finding

03 - Automatic with auxiliary ranging

05 - Automatic with multiple VLF-Omega frequencies

06 - Automatic cross chain Loran-C

07 - Automatic with auxiliary wind profiler

08 - Automatic satellite navigation

8 - Indicator

GG - Hour UTC of release

gg - Minute of release

41414 - Cloud Data  $N_h C_L h C_M C_H$

$N_h$  - Amount in eighths of all the  $C_L$  present or, if no  $C_L$  is present, the amount of all the  $C_M$  present.

$C_L$  - Type of low cloud present

$h$  - Height above surface of lowest cloud seen

$C_M$  - Type of middle cloud present

$C_H$  - Type of high cloud present

PPBB 56000 91285 90012 01009 01003 00502 90346 32002 26003  
20502 90789 21005 23508 27013 91245 26512 27016 26514 9169/  
31013 33026 9205/ 32523 32025 93013 31034 31538 29542 935//  
30547 949// 30024 9504/ 30025 32037=

PPBB YYGGa<sub>4</sub> Iiiii 9t<sub>n</sub>uuu dffff dffff dffff 9tnuuu dffff dffff dffff=

YYGGa<sub>4</sub> Iiiii dffff - Previously described

9 - Indicator to show winds in units of 300 meters or 1,000 foot increments

t<sub>n</sub> - Indicates tens digit of altitude - 0 = less than 10,000 feet 1 - 10,000 - 19,000 feet

u - Indicates the unit value of altitude of winds

91285 TTCC 56002 91285 70858 76757 05508 50059 63959 11005  
30378 54160 06009 20638 51161 07512 88922 82356 33014 77999=

TTDD 5600/ 91285 11922 82356 22700 76757 33517 64359 44472  
64959 55364 57560 66130 47162=

PPDD 56000 91285 9556/ 32522 33015 970// 13004 98047 08012  
09512 07012 99015 08012 08011 05005=

### Breakdown for 101A<sub>df</sub>A<sub>df</sub> - Miscellaneous Regional Data

#### Code Figure

#### Definition

40 - 59	Reason for no report or an incomplete report
40	Report not filed
41	Incomplete report; full report to follow
42	Ground equipment failure
43	Observation delayed
44	Power failure

45	Unfavorable weather conditions
46	Low maximum altitude (less than 1500 feet above ground)
47	Leaking balloon
48	Ascent not authorized for this period
49	Alert
50	Ascent did not extend above 400 hPa level
51	Balloon forced down by icing conditions
53	Atmospheric interference
54	Local interference
55	Fading signal*
56	Weak signal*
57	Preventive maintenance
58	Flight equipment failure (transmitter, balloon, attachments, etc.)
59	Any reason not listed above

\* Fading signals differ from weak signals in that "fading signals" are first received satisfactorily, then become increasingly weaker, and finally become too weak for reception, while "weak signals" are weak from the beginning of the ascent.

#### 60 - 64: Miscellaneous

62	Radiosonde report precedes
64	Stability index follows: 000I <sub>s</sub> I <sub>s</sub>

#### 65 - 69: Doubtful Data

65	Geopotential and temperature data are doubtful between following levels: 0P <sub>n</sub> P <sub>n</sub> P' <sub>n</sub> P' <sub>n</sub>
66	Geopotential data are doubtful between the following levels: 0P <sub>n</sub> P <sub>n</sub> P' <sub>n</sub> P' <sub>n</sub>
67	Temperature data are doubtful between the following levels: 0P <sub>n</sub> P <sub>n</sub> P' <sub>n</sub> P' <sub>n</sub>
68	Dew point depression is missing between the following levels: 0P <sub>n</sub> P <sub>n</sub> P' <sub>n</sub> P' <sub>n</sub> (not used when T <sub>n</sub> T <sub>n</sub> is also missing)

70 - 74 Not allocated

### Breakdown for 101A<sub>df</sub>A<sub>df</sub> - Miscellaneous Regional Data (Continued)

#### 75 - 89 Corrected Data

78	Corrected tropopause data section follows
79	Corrected maximum wind section follows

80	Corrected report for the entire report ( <i>first*</i> and <i>second*</i> transmissions) follows
81	Corrected report of the entire PART A and/or PART B precedes
82	Corrected report of the entire PART C and/or PART D precedes
83	Corrected data for <i>mandatory levels**</i> follow
84	Corrected data for <i>significant levels**</i> follow
85	Minor error(s) in this report; correction follows
86	<i>Significant level(s)</i> not included in original report follow: //P <sub>n</sub> P <sub>n</sub> P <sub>n</sub> T <sub>n</sub> T <sub>n</sub> T <sub>n</sub> D <sub>n</sub> D <sub>n</sub> or P <sub>n</sub> P <sub>n</sub> P <sub>n</sub> T <sub>n</sub> T <sub>n</sub>
87	Corrected data for <i>surface</i> follow
88	Corrected <i>additional data</i> groups follow: 101A <sub>df</sub> A <sub>df</sub> .... etc.
90 - 99	
90	Extrapolated geopotential data follow: P <sub>n</sub> P <sub>n</sub> h <sub>n</sub> h <sub>n</sub> h <sub>n</sub> (d <sub>n</sub> d <sub>n</sub> d <sub>n</sub> f <sub>n</sub> f <sub>n</sub> )
94	Averaged wind for the surface to 5000 foot MSL layer and the 5000 to 10000 foot MSL layer follows: ddfff ddfff (can be used in the PART A message)

**Note:** Numbers not shown have no assigned meaning or do not pertain to NWS upper-air sites.

Unless both the stability index and the mean winds are missing, the Part A message always contains two special 101 groups as follows:

**10164** Group that identifies stability index.

**10194** Group that identifies the mean winds.

A 5-character group 000I<sub>s</sub>I<sub>s</sub> follows the 10164 which contains the encoded stability index. The I<sub>s</sub>I<sub>s</sub> value that appears in the coded message for the stability index is interpreted as follows:

<u>Code Value</u>	<u>Stability Index Table</u> <u>Meaning</u>
00 to 40	Stability index is 0 to 40
51 to 90	Stability index is -1 to -40
91	RH < 20% at either base or 500 mb level or calculation failed.
92	RH is missing at the base level.

The 10194 group for mean winds from the surface to 5000 feet MSL and from 5000 to 10000 feet MSL are encoded in two code groups using the format d<sub>m</sub>d<sub>m</sub>f<sub>m</sub>f<sub>m</sub>f<sub>m</sub>, where d<sub>m</sub>d<sub>m</sub> is the mean direction and f<sub>m</sub>f<sub>m</sub>f<sub>m</sub> is the mean wind speed. If the mean wind is missing, it is reported as /////. If winds for both layers (i.e. Sfc. - 5K and 5K to 10K feet MSL) are missing, the 10194 is not sent.



Additional 101 groups as shown in the Table can be entered after the 51515 as long as the last two digits are in ascending order with the other groups. For example, if the report has been corrected, this section would appear as follows:

51515 10164 00092 10181 10194 ///// 26516=

DRAFT

## APPENDIX G - TERMINATING AND ARCHIVING THE OBSERVATION

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1. Introduction: This appendix explains flight termination procedures and data archiving. It is important to remember that these tasks should be completed after reviewing the data. The observer should determine the point of termination, termination reason, and that all data is accurate and should be archived. The software can not select the correct reason for termination for every occasion. The observer should verify the accuracy of the flight data throughout the flight, prior to transmission and again prior to data archiving.

**Note:** RRS observers should follow instructions in Chapter 11 of the RRS User Guide.

2. Termination: The common reasons an observation is terminated are:
- Balloon burst:** Nearly all flights terminate due to balloon burst. A plot of pressure versus time will show a change to increasing atmospheric pressure values. The system detects this and initiates an automatic termination.
  - Floating balloon:** The system can detect the signal trend characteristics of a floating balloon (i.e., nearly constant altitude). The software will usually terminate the observation.
  - Weak or fading signals:** Missing data results when radiosonde signals become weak or fade in and out. If this continues the system will terminate the observation.

2.1 Automatic Termination: When the observation is automatically terminated, the observer must look at the data to decide if the reason for termination and point of termination selected is correct.

It is important to check all data for correctness before transmitting coded messages. The observer should always go into the “MET” and “POSITION” data and look to see that the flight was terminated at the right point. One should look for:

- a. Realistic ascension rates - No balloon should ascend faster than 500 meters/minute. Check the heights in the “MET” data and compare the heights at different times and divide the height difference by the minutes between the heights selected.
- b. Realistic “Pressure vs. Time” plot - There should be no abrupt changes in the pressure profile prior to termination. If a failed or leaking pressure cell is detected by a flattening out of the plot or if there is an abrupt jump in the plot terminate the flight prior to the occurrence.
- c. No duplicate levels at or near the termination point - The observer should type “LE” and check the last level and the level preceding it to ensure there is at least 0.1 hPa difference in the values. If there is a duplicate level, the last level should be deleted by hitting the “F8” key. The “ESC” key may be pressed to exit the screen. Because there was a change to the observation, “CO” must be typed to save the changes.

**Note:** MicroART does have a status check message for “Duplicate Pressure Levels” and if displayed, the observer should go into the Levels and eliminate the last level selected following the instructions in 2.1.

The observer can then edit and transmit the coded messages, as discussed in Chapter 9 and 10 of the MicroART Training Guide.

After transmitting the coded messages, exit the “ART Observation” option following procedures described in Chapter 11 of the MicroART Training Guide.

2.2 Manual Termination: A flight may reach a point where it should be terminated, but MicroART has not terminated the flight. In such cases the observation should be terminated manually. The following step should be performed to manually terminate an observation:

At the?> prompt, TERM should be typed and the [Enter] key hit.

3. Point of Termination: Validation that the proper point of termination has been selected must be made. This involves following the procedures as indicated in section 2.1.

4. Reason for Termination: MicroART provides multiple reasons for observation termination:

- a. Balloon burst
- b. Balloon forced down by icing
- c. Floating balloon
- d. Weak signals
- e. Battery Failure
- f. Ground Equipment Failure
- g. Signal Interference
- h. Radiosonde Failure
- i. Excessive Missing Data
- j. Other

When an upper-air observation is terminated, one reason from the list must be selected and entered into MicroART.

5. Termination at Predetermined Level: If required, a special observation can be terminated when it reaches a predetermined pressure level. This pressure level is entered on MicroART's Administrative Data screen. Termination procedures for this type of observation are identical to those for the automatic termination method in Section 2.1.

6. Data Archival: Data should be archived at the end of each flight. Flights with problems should have the "Log" and "Store" diskettes saved and set aside for further evaluation. If the data is to be sent to the Regional Upper-Air Program Manager or the NWS Upper-Air Program Office for further evaluation, a copy of the calibration data file and a statement of what happened with pertinent plots to help illustrate the problem.

Send Data to: National Weather Service Headquarters  
1325 East-West Highway  
SSMC2, Room 4466  
Silver Spring, MD 20910

To archive the data:

- a. Go into the "Archive" option and select "Transfer Archive File". Follow instructions shown in Chapter 12 of the "MicroART Training Guide".
- b. After archiving is complete, exit out of the "Archive" option and return to the

“ART Main Menu”.

- c. Select the option, “Exit to DOS”.

7. ART Shutdown Procedures: When the balloon has burst or the sounding is to be terminated, the “STOP PRINT” switch on the Master Control Unit must be pressed. “The STOP PRINT” switch must be pressed for at least one second to ensure proper operation. This will stop the timer that records the flight duration since the release switch was pressed to begin the flight.

7.1 Standby - ART System Components: Placing the equipment in standby, in anticipation of another flight, eliminates the necessity of equipment warm-up and performing all operational checks. To place the equipment in standby the observer must do the following at the Master Control Unit:

- a. Turn the target antenna on.
- b. Aim the reflector at the target antenna and with the motors in “Near Auto” to allow the antenna to lock on the target antenna.
- c. The antenna should read within  $\pm 0.05$  degrees in both elevation and azimuth of the surveyed points for the target antenna. If it is not within tolerance, another attempt to lock-on the target antenna should be performed. If this fails, a NWS Form A-26 should be completed and the electronics technician notified.
- d. Press the STANDBY button.
- e. Leave the MicroART computer on.

7.2 Power Down - ART System Components: To power down equipment: The following should be accomplished at the Master Control Unit (MCU):

- a. Instructions in section 7.1 should be followed ignoring item e. “POWER” switch on MCU should be set to OFF.
- b. After the flight has been archived, the operator should at the MicroART Main Menu select “Shut Down System” when completed, then turn off the printer display and the IBM XT at the power source.

## APPENDIX H – QUALITY CONTROL OF DATA

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1. Introduction: Although upper-air observers are required to quality control their soundings prior to dissemination, not all data errors or problems can be identified, corrected, or deleted. Effective data quality control is a multi tiered process involving the upper-air observer, NCEP, NCDC, and administrative offices at the regional and national level. This Appendix provides an overview of how upper-air soundings are quality controlled.

2. Upper-Air Station Observer: Each observer will quality control their soundings prior to dissemination. Do not assume someone else will detect and correct the errors. Chapters 9 and 14 of the MicroART Training Guide and Chapter 9 and 13 of the RRS Training Guide provide instructions and procedures for handling questionable and erroneous data. There will be situations (e.g., severe weather outbreak) where the workload will preclude the checking the validity of the sounding data prior to transmission. If such a situation occurs, transmit the data and archive it accordingly. However, at a later date check the validity of the flight archive data and edit it as required. Chapter 5 of the MicroART Training Guide and Chapter 4 of the RRS Training Guide provide instructions on reworking a flight.

The observer and the station manager should review all quality control reports received from NCEP, NCDC, Regional Headquarters, and WSH. These reports, as well as the station's WS Form B-29 information, will help identify data errors that missed detection and detect long-term, on-going data problems.

Sites will follow prescribed operating procedures shown in this manual and the appropriate Training Guide. All observers should be familiar with the Training Guides and understand that Regional and WSH personnel monitor the flight data from sites as does NCEP and NCDC. Disregard of proper procedures and policies will result in a degradation of the site's performance and will be reflected in statistics compiled for evaluating the network's and site's performance. Data quality is essential to the observing program.

3. National Centers for Environmental Prediction (NCEP): Before inputting radiosonde data into numerical weather prediction models, NCEP corrects Sippican (VIZ) B2 temperature data for solar and infra-red radiation and checks the quality of the data using objective and subjective techniques.

Solar and infra-red radiation typically affects the Sippican (VIZ) temperature data at pressures less than 100 hPa (see appendix A section 3.2.3). The temperature errors caused by radiation can exceed 1°C. Since the observers do not have the tools to determine the extent of the temperature errors caused by radiation, they are not expected to correct the data.

The RRS software uses the cloud group to adjust a solar radiation correction or algorithm to more accurately reflect the temperature without the solar affects on the temperature data. Entering of accurate cloud and weather data is necessary to ensure the correct algorithm is used.

NCEP data quality checking utilizes a computerized comparison of the actual upper-air data received from an upper-air station with that generated from a 6-hour first guess numerical weather prediction model. If the temperature, geopotential height, and/or wind data compare poorly, the upper-air data are either deleted, corrected, or remain. Typically, most data deletions are for temperature and height data at pressures less than 300 hPa.

Upper-air charts are also examined to help find bad data not flagged by MicroART and to determine if data flagged as bad by the software are actually good. It should be noted that at present, RH data are not as closely checked for accuracy as are the other radiosonde data because data analysis tools have yet to be fully developed. Lastly, NCEP's quality control methods are not perfect and errors do pass through undetected. Thus it is very important that the observer checks the validity of the sounding data before it is disseminated.

Observers can review a summary of the NCEP upper-air data quality control by reading the "Special NCEP Discussion" obtainable on AWIPS. These messages include a log prepared by the SDM on what soundings had data problems, what soundings were late or missing, and other information related to NCEP operations. Information on NCEP upper-air data quality control is issued daily at about 03:00 and 15:00 UTC.

Observers should not be alarmed if, on occasion, all or a portion of their sounding is flagged as having bad data. Although the sounding data may pass all the MicroART data checks, NCEP has different tools for assessing data quality not available at the upper-air site. However, if it is noticed that station soundings are often flagged with bad data, there may be a problem with the ground equipment, radiosondes, or incorrect observational procedures.

4. National Climatic Data Center (NCDC): Similar to NCEP, NCDC relies on a mix of objective and subjective procedures to quality control the upper-air data before it is archived. NCDC checks RH data quality (primarily for rapid, unrealistic fluctuations in RH). Each sounding undergoes a series of checks to determine the plausibility of all available data. If data is determined to be suspect or clearly erroneous, it is flagged as such, but is not deleted from the archive.

Each month NCDC prepares an “Upper Air Quality Assurance Report” for each upper-air station. The report lists all the data flagged during the month. The Regional Headquarters receives these reports for further distribution to each station.

Don’t be too concerned if NCDC finds errors the observers did not detect. NCDC applies quality control techniques not available to the field sites. However, NCDC’s data quality assurance program does not detect all errors. This is why special care must be taken to ensure that the soundings are checked for errors prior to being mailed to NCDC. If NCDC finds frequent problems with soundings from a site, the observers should work together to determine if station equipment or operational procedures are the cause.

5. Regional Headquarters: The Regional Upper-air Program Manager, at a minimum, prepares a quarterly report summarizing upper-air station performance for the stations in their region. Data for this report comes from the various upper-air forms (e.g., the WS Form B-29) stations fill out each month, as well as data quality reports prepared by WSH. This report provides useful performance information (e.g., average burst altitudes) not found in the NCEP or NCDC reports. This report should be available for site review. If a site is performing poorly compared to other stations, the site should contact the Regional Upper-Air Program Manager to discuss the problems and determine possible solutions.

6. Weather Service Headquarters: WSH analyzes daily soundings, as well as data quality reports and correspondence from NCEP, NCDC, and the Regional Offices. Stations with serious or ongoing data problems are identified. WSH coordinates its findings with Regional Offices and provides possible causes for the problems and recommended solutions. To aid in this effort, WSH provides monthly summaries of station performance on the Internet ([www.ua.nws.noaa.gov](http://www.ua.nws.noaa.gov)).



## APPENDIX I – COMPLETION OF DOCUMENTATION FORMS

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1. **Introduction:** Keeping records of upper-air sounding performance, flight equipment, and logistics is a key component of the upper-air program. This information is used to determine if the station is operated and maintained in accordance with established procedures and to help manage upper air supplies. A number of forms are used to collect this information and this appendix provides information on their completion and submission.

**It is essential that all upper-air forms are completed with accurate information and submitted in a timely manner.**

2. **Upper-Air Forms:** This Appendix includes the completion and submission of the following forms:

- a. WS Form B-29 - Rawinsonde Report
- b. WS Form B-85 - Rawinsonde Inventory
- c. WS Form H-6 - Report of Defective Radiosondes
- d. WS Form A-22 - Special Upper-Air Observation Report
- e. WS Form H-14 - Equipment Return Tag
- f. WS Form B-17 - Rawin-Theodolite Comparison

3. Completion and Submission of Forms: Currently three upper air forms, WS Form B-29, WS Form B-85, and WS Form H-6 are completed and submitted to WSH via a NWS upper-air forms website. Other forms will be added to the website as time permits. Station staff should consult their Regional Office Upper-Air Program Manager for the latest URL to this website and to request user accounts for new observers so that they can get access to the forms.

WS Forms A-22, H-14 and B-17 are completed using Word or other approved software and sent via email or regular mail to appropriate NWS staff as directed.

3.1 WS Form B-29, Rawinsonde Report: WS Form B-29 is accessed via a NWS website and is submitted each month. Begin this form with the scheduled 0000 UTC flight on the first day of the month. Flight information should be logged into the form after each observation. However, station staff have the option to wait until the end of the month to complete the form, but it must be submitted within two days 2 days after the end of the reporting period.

Caribbean upper-air stations funded by WSH should also submit the form using the NWS website. If they can not access the website they should prepare three copies of WS Form B-29. One copy should be sent to the WSH Upper-Air Program Office, and WSH Maintenance Logistics and Facilities Branch. The final copy should be kept on station for at least 3 years.

**Note:** Effective June 1, 2005, WS form B-47 (Rawinsonde Monthly Transmittal) was merged with the WS Form B-29. Completion of WS-Form B-47 is no longer required.

**Entries on WS Form B-29** should be made as follows:

- a. Station Information- The station name and the four letter station identification number (SID), the name of the person preparing the form, the form date, number of flights, and the flight ascension numbers are automatically filled in. This information should be checked for accuracy and WSH notified if errors are found.
- b. Ground and Flight Equipment-
  - 1). Rawin - Rabal Comparison - Latest RMS - Enter the RMS and date of the last comparative.
  - 2). Date of Last Alignment - Select the date of the last receiver and tracking alignment check by the site electronic technician.
  - 3). Orientation Check - Entry should be "Daily". If this check is not completed before each flight, indicate the reason why in the "Remarks" block.
  - 4). Total Number of Soundings with Limiting Angles - Enter the total number of soundings where the limiting angle condition (i.e., no winds were calculated for a period of time) occurred.

- 5). Theodolite General Test - This test is performed quarterly. Enter the elevation (EL) difference, azimuth (AZ) difference, and data of latest test. Maximum allowable tolerance is  $\pm .2$  degrees.
- 6). Rejected Balloons - Enter the balloon manufacturer, lot number or date of manufacture, and select the reason for rejection. Include in the remarks section balloon type, size, and type of defect for each balloon rejected during the period of the report.

**Note:** Upper-air stations using the Radiosonde Replacement System (RRS) or Loran tracking systems do not need to make entries for items 1 through 5.

- c. Unsuccessful Releases- Make entries for all flights released that did not reach 400 hPa. This includes flights not assigned an ascension number. Whenever entries are made for an unsuccessful release and the cause of the early termination is known, document the problems encountered during the flight. As an example, if battery problems were suspected, be sure that all information on the battery is listed.
- d. Missed and Special Flights:
  - 1). Missed Observations - Enter the date, time, and reason when a scheduled observation is not taken. In the remarks section provide additional information on the missed flight and corrective actions made.
  - 2). Special Observations - Enter the date, time of release, and the reason for taking a special. In the remarks section, note who requested the special observation. (e.g, Project Cosmos, National Hurricane Center, Lead Forecaster)

**Note:** Enter only special soundings that have been assigned an ascension number and sent to NCDC for archival.

- e. Station Operation and Equipment Remarks: All other pertinent remarks not included in other sections of the form should be included in this block. Mandatory remarks include:
  - 1). Effective date and time of changes in the upper-air program. This includes instructional changes, change in the type of radiosondes used or the number of routine observations per day, installation of new upper-air equipment, and equipment modifications.
  - 2). Ground equipment problems encountered and corrective actions taken. When a system or a component of a system has been inoperative during the period covered by the report, enter the name of the system or

component and dates out of service and back in service

- 3). Corrections to entries on preceding WS Form B-29's. A brief, but complete explanation should be included.
  - 4). Continuation of remarks from the remarks section in the Flight Summary section of the form.
  - 5). If wind data were lost due to limiting angles, include the height boundaries of the limiting angles for each flight. This may also be logged in the remarks section of the Flight Summary.
- f. Flight Summary Information: Make entries in the Flight Summary for each observation that is assigned an ascension number. Flights taken for test purposes or comparatives would be logged in the Special releases and a note made in the "Remarks" column. Make entries as follows:
- 1). Ascension Number (ASCNO) - List each flight that has been assigned an ascension number.
  - 2). Date (UTC) - Select the month and day of the observation.
  - 3). Observation (OBS) Time (UTC) - Enter the observation time to the nearest whole hour, UTC; (e.g., "12" would be entered for the 1200 UTC sounding.
  - 4). Radiosonde Serial Number - Enter the complete radiosonde serial number. This includes letter designations that are a part of the radiosonde serial number.
  - 5). Sonde Type - Select the radiosonde type.  
RDF = Radio Direction Finding  
LRN = Loran  
GPS = Global Positioning System
  - 6). Balloon Manufacturer - Select the appropriate balloon manufacturer.
  - 7). Lot Number or Date of Manufacture - Enter the balloon lot number. If not available, enter the date of balloon manufacture printed on the balloon bag or shipping box.
  - 8). Nozzle Lift - Enter the value to the nearest 100 grams or cubic foot.
  - 9). Balloon Ascent Rate - Enter the ascent rate of the balloon from the surface to the 400 hPa level and from the 400 hPa level to flight termination. Enter the values to the nearest meter.

- 10). RAOB Termination - Select the reason for termination.
- 11). Height - Enter the termination height of the sounding to the nearest meter.
- 12). Remarks - Enter remarks concerning anything unusual about the flight. If additional space is needed, the remarks should be continued in the Station Operation and Equipment Remarks section.
- 13). Observer - Enter the initials of the observer who took the observation.

3.2 WS Form B-85, Rawinsonde Inventory: WS Form B-85 is accessed via a NWS website and should be completed promptly at the end of each month. Check all entries for accuracy and submit the form within 2 days of the end of the month.

Caribbean upper-air stations funded by WSH should also submit WS Form B-85 using the NWS website. If the web site can not be accessed, then prepare three copies of the form. One copy should be sent to the WSH Upper-Air Program Office, and WSH Maintenance Logistics and Facilities Branch. The final copy should be kept on station for at least 3 years.

Entries on WS Form B-85 will be completed as follows:

- a. Station Information: The station name and the four letter station identification (SID), the name of the person preparing the form, and the date are automatically filled in. This information should be checked for accuracy and WSH notified if errors are found.
- b. Monthly Inventory - Part I: Columns identified as "Radiosondes and Balloons" are divided into sub-columns. This is for the sites having more than one type of radiosonde or balloon type on station. In such instances, separate inventories for each type of radiosonde or balloon are required.

Make the following entries:

- Line 1. Beginning Balance - Enter the total number of radiosondes and balloons at the start of the month.
- Line 2. Quantity Received During Month - Enter the number of radiosondes and balloons received during the month.
- Line 3. Total Available During Month - The total of line 1 and line 2.
- Line 4. Released During Month - Total number of radiosondes and balloons released in the month. This includes the number used for additional releases and comparisons.

- Line 5. Quantity of Serviceable Items Shipped - Indicate the number of serviceable radiosondes or balloons shipped during the month. Indicate in "Remarks" the site to which they were shipped.
- Line 6. Number of Items Rejected - Number of radiosondes and balloons rejected for whatever reason.
- Line 7. Total Used - Total number of radiosondes and balloons used during the month. This is the sum of line 4, line 5, and line 6.
- Line 8. Ending Balance - Number of serviceable radiosondes and balloons on hand at the end of the month. This is the difference from line 3 and line 7. Do not include rejected items.
- Line 9. Ending Balance - Number of serviceable radiosondes and balloons on hand at the end of the month by actual count. **Do not leave this entry blank.**
- Line 10. Defective Items on Hand - The number of defective radiosondes and balloons on hand at the end of the month.
- Line 11. Quantity of Defective Items Shipped - Total number of defective radiosondes and balloons shipped during the month to the National Reconditioning Center (NRC). Contact WSH for instructions on where to ship defective balloons.
- Line 12. Surplus Hygristors on Hand - Quantity of usable spare hygristors on hand at the end of the month.
- Line 13. Surplus Batteries on Hand - Quantity of usable spare batteries on hand at the end of the month.
- Line 14. Shipment Number - Enter the shipment number taken from the outside of the radiosonde or balloon box.
- c. Supplemental Inventory and Remarks - Part II - Take an end of the month inventory of all upper-air expendables and fill in the appropriate form entries. This includes the count of individual cylinders of lifting gas, lighting units, train regulators or dereelers, parachutes, and rolls of twine. **Do not enter the quantity of boxes or cases in stock.**
- d. Flight Summary:
- 1). Number of 2<sup>nd</sup> Releases - Enter the total number of second balloon releases during the month.

- 2). Number of 3<sup>rd</sup> Releases - Enter the total number of third releases during the month.
- 3). Number of Special Releases - Enter the number of special releases for whatever reason.
- 4). Number of Unsuccessful releases and flights - Enter the total number of releases that did not reach 400 hPa.

**Note:** This number must be equal to or greater than the total number of 2<sup>nd</sup> and 3<sup>rd</sup> releases.

- e. Remarks - include information about supplies. This includes items missing from a shipment, excessive number of batteries rejected, damage to shipments, and the balloon and radiosonde type if listed as “other”. Use this space as a continuation sheet for Part I whenever necessary.

3.3 WS Form H-6, Report of Defective Radiosondes and Batteries: WS Form H-6 is accessed via a NWS website and should be filled in and submitted as radiosondes and batteries are rejected. At a minimum, the form must be completed and submitted within 2 days after the end of each quarter. When shipping a box of rejected Radiosondes to NRC, a hard copy of the H-6 form should be enclosed within each box of the shipment.

Caribbean upper-air stations funded by WSH should also submit WS Form H-6 using the NWS website. If the website can not be accessed, prepare three copies of the form. One copy should be sent to the WSH Upper-Air Program Office, and WSH Maintenance Logistics and Facilities Branch. The final copy should be kept on station for at least 3 years.

**Note:** Rejected Batteries will not be shipped to NRC. Contact WSH for information on where they should be shipped.

Entries on WS Form H-6 will be completed as follows:

- a. Station Information - The station name and the four letter station identification (SID), the name of the person preparing the form, and the form period are automatically filled in. This information should be checked for accuracy and WSH notified if errors are found.
- b. Radiosonde Serial Number - Enter the complete radiosonde serial number for each instrument or battery rejected. This includes letter designations that are a part of the radiosonde serial number
- c. Date on Sonde - Select the date the radiosonde was manufactured. This is typically stamped on the outside of the radiosonde. If there is no stamped date, check the shipping information sheet or calibration diskette for the date.

**Note:** Vaisala radiosondes have the month and year printed on the radiosonde calibration diskette as “Manufacturing Date: yy-mm”

Where "yy" is the year and "mm" is the month. Example: 04-05 means May, 2004

If the day of the month is missing on the cal diskette, use "15" in the H-6 form entry.  
Example: 05/15/04.

- d. Date Rejected - Select the date the radiosonde or battery was rejected.
- e. Reason for Rejection - Select the reason for rejecting the radiosonde or battery.
- f. Specific Information on why the radiosonde (or battery) was rejected. Provide a description of the defect, if known. If unknown, describe the performance which resulted in the rejection.

**Note:** A radiosonde being returned that was not defective, but is being sent back for reconditioning should be identified as such. (i.e., Instrument returned to office by the public)

- g. 1<sup>st</sup> Obs Inits and 2<sup>nd</sup> OBS Inits. Enter the initials of the two persons who determined the radiosonde or battery was defective. All rejected radiosondes and batteries should be rechecked by someone other than the person who initially rejected the radiosonde initially.

**Note:** Ship defective radiosondes by parcel post to NRC. Ship defective radiosondes every 90 days, at a minimum, to ensure the one year warranty does not lapse. Rejected batteries will not be sent to NRC. Contact WSH for information on where to ship.

3.4 WS Form A-22, Special Upper-Air Observation Report: WS Form A-22 is used to report special upper-air observations taken for agencies outside the NWS. This form is not required for special soundings requested for “Operational Purposes”. However, soundings requested for “Research Purposes” or for outside agencies should be entered on the form.

Submit the form at the end of each month when non-NWS special upper-air soundings are taken. This form should be sent no later than 2 days after the end of the month. Submit a separate set of forms for each reimbursable special project. Prepare the form in triplicate and submit the original to the Regional Upper-Air Program Manager, a copy to the WSH Upper-Air Program Office, and keep a copy on file at the station for at least 3 years.

All reimbursable special observations must be approved at both the regional and national headquarters. Personnel time, including overtime, used while taking special upper-air soundings is submitted on the Time and Attendance reports. The maximum overtime allowed for an upper-air flight is 3 hours. Entries on the A-22 will show the date and time of the special sounding, the project name, and the number of hours overtime worked for each special sounding taken.



Entries on WS Form A-22 will be completed as follows:

- a. Station - Enter the station name and the four letter SID.
- b. Date – Date the form was prepared, usually near the end of the month or when the set of specials for the project are known to be completed.
- c. Total Number of Observations - Number of special project observations taken that month.
- d. To - Copies should be sent to the Regional Upper-Air Program Manager and to the NWS Upper-Air Program Office
- e. Project Name - Code name of the special project as supplied by the NWS Upper-Air Program Office or the Region.
- f. Number of Radiosondes Used - Number of each type of radiosonde used during the month for the special project.
- g. Release Date and Time - Release date and time (UTC) for each special sounding taken for the project. Include the number of hours overtime worked for each flight. Maximum allowed per flight is 3 hours.
- h. Prepared by Signature - The form is usually prepared and signed by the station manager or the Upper-Air Focal Point on site.

3.5 WS Form H-14, Equipment Return Tag: WS Form H-14, Equipment Return Tag, should be used to return defective balloons to the National Reconditioning Center. Each balloon found to be defective should have a tag tied to it and returned to NRC prior to its 1 year warranty expiration.

Stations will mail the original to the National Reconditioning Center in Kansas City and keep a copy of the WS Form H-14 on station for a minimum of 3 years.

Send to: National Reconditioning Center  
1520 E. Bannister Road  
Kansas City, MO 64131-3009  
Attn: W/OSO322KC

Entries on the WS Form H-14- Entries will adhere to the following format:

- Line 1. Station Call Letter Identifier - Enter the station's 4 letter SID.
- Line 2. Organization Code - Enter the station's organization code. Obtain the code from the station manager or the administrative assistant if unknown.

- Line 3. Task Number - Enter 8M1J10
- Line 4. Failure Date - Enter the date the balloon failed or was found to be defective.
- Line 5. Item Name - Enter balloon type (e.g., Balloon HM30). This designator should be on the outside of the balloon box. It is also the designator used by NLSC.
- Line 6. NWS Stock Number - Enter the ASN used at NLSC.
- Line 7. Item Serial Number - Enter N/A (There is no serial number for individual balloons).
- Line 8. Chassis S/N - Enter N/A
- Line 9. Primary Reason for Return - Enter an "X" as the appropriate reason or enter "Other" and explain in item #11.
- Line 10. EMRS Failure Report No. - Leave Blank (Does not apply)
- Line 11. Defective Component, Description of Malfunction or Reason for Return - Elaborate on the reason for return (i.e, "Balloon had pinholes")
- Line 12. Completed by and Telephone No. - Enter observer name and the office telephone number.

**Note: Items 13 - 18** - Leave blank. (Items are for National Reconditioning Center)

3.6 WS Form B-17, Rawin-Theodolite Comparison: Unless there is a Regional Supplement stating otherwise, all sites using RDF equipment should perform a quarterly optical comparison and enter the information on WS Form B-17, Rawin-Theodolite Comparison. This requirement is essential in determining if the equipment is operating to standards. Overtime is authorized to ensure this requirement is met.

The comparison will be used to calibrate the rawin equipment. It is of utmost importance that the rawin and theodolite readings be made accurately and double checked to ensure errors are avoided. Copies of the WS Form B-17 or its equivalent should be mailed to the Regional Upper-Air Program Manager and kept on station a minimum of 3 years.

Entries of the WS Form B-17- Entries will adhere to the following format:

- a. Station and Equipment Information:
  - 1). Station - Enter the station name and the four letter SID.

- 2). Type of Rawin Equipment - Enter GMD (ART-1), WBRT (ART-2) as appropriate.
  - 3). Receiver - Enter receiver serial number. (Check with site el tech or look at earlier forms).
  - 4). Antenna Control - Enter antenna control's serial number. (Check with the site el tech or look at earlier forms).
  - 5). Pylon - Enter pylon's serial number. (Check with site el tech or look at earlier forms)
  - 6). Date and Time of Release (UTC) - Enter the release time in UTC.
- b. Angular Data Entries - Angular data entries will adhere to the following methods:
- |           |   |
|-----------|---|
| Column 2. | Theodolite Azimuth Angles - Enter the azimuth angles to the nearest 0.1 degrees.  |
| Column 3. | Theodolite Minus Rawin - For each fifth minute of the observation, subtract algebraically the rawin azimuth angle from the corresponding theodolite angle and enter this difference, with the proper sign, in column 3 of the WS Form B-17. This difference should not exceed 0.5 degrees.  |
| Column 4. | Theodolite Elevation Angles - Read the elevation angles to the nearest 0.01 degrees.  |
| Column 5. | Theodolite Minus Rawin - Beginning with minute 11, subtract algebraically the rawin elevation angle from the corresponding theodolite angle and enter this difference, with the proper sign. Omit the subtraction whenever the rawin elevation angle is greater than 60 degrees or is within the limiting-angle zone. The difference between the rawin and theodolite elevation angles should not exceed 0.5 degrees. |
| Column 6. | Min. By Min. Change in Col. 5 - Compute the minute-by-minute changes in the differences between the rawin and theodolite elevation angles (column 5) and enter the changes, with the proper sign. For example, the first entry between minutes 11 and 12 would be the remainder of minute 11 minus minute 12.   |
| Column 7. | Square of Column 6 Entries - Square the column 6 entries and enter.   |
- c. Summary Information. Use the following examples:

- 1). Sum of Col. 7 - Obtain the sum of all entries in column 7 and enter the value on line a.
  - 2). Line “a” Divided by No. Of Entries in Col. 7 - Divide the sum (line “a” by the number of entries in column 7). Enter the mean on line b.
  - 3). Square Root of Line “b” (Root Mean Square Difference) - Obtain from the Table of Average Root Mean Squares what the value from line ‘b’ should equate to and enter into item “c”. (For example: If the value of line b is 0.0020, the entry for line c would be 0.045.)
- d. Observer and El Tech’s Information - Adhere to the following format:
- 1). Theodolite Observer - Enter the theodolite observer’s name.
  - 2). Computer - Enter the name of the person doing the computations.
  - 3). El Tech’s Initials - The electronics technician must initial the WS Form B-17 and take appropriate action.
  - 4). Date - Date the WS Form B-17 was reviewed by the electronics technician.
  - 5). Action Required - Yes or No.

**Note:** Use the following procedures:

- a. RMS value is 0.050 or less: The electronics technician will examine the form to determine the need for maintenance, and initial the forms after which they will be forwarded to the Regional Upper-Air Program Manager with the current WS Form B-29. If the electronics technician is expected to be absent from the station for more than 7 days, the forms will be forwarded without his/her initials to the Regional Upper-Air Program Manager with the current WS Form B-29.
- b. RMS value is greater than 0.050: Hold the forms at the station until corrective action is taken. After the action is completed, send the forms to the Regional Upper-Air program manager with the current WS Form B-29. Another comparative observation should be taken as soon as corrective action has eliminated the problems causing the excessive RMS values. This should be completed within 3 days of the corrective action. Also, a comparison will be taken following major component repair or replacement. The WS Form B-17 or its equivalent should be forwarded to the Regional

Upper-Air Program Manager and a copy kept on station a minimum of 3 years.

4. Forms Required to be on Station: The following forms are required at each site either in an electronic format or as a hard copy.

<b>WS Form A-22</b>	<b>Special Upper-Air Observation Report</b>
<b>WS Form A-26</b>	<b>Maintenance Record</b>
<b>WS Form B-17</b>	<b>Rawin-Theodolite Comparison (Not Required for RRS sites)</b>
<b>WS Form B-29</b>	<b>Rawinsonde Report</b>
<b>WS Form B-33</b>	<b>Station Inspection Report</b>
<b>WS Form B-48</b>	<b>Upper-Air Program Review Guide</b>
<b>WS Form 10-1304-1</b>	<b>Certificate of Authority to take Weather Observations</b>
<b>WS Form B-79</b>	<b>Data Sheet for Balloon Flight Tests (Balloon test sites only)</b>
<b>WS Form B-85</b>	<b>Rawinsonde Inventory</b>
<b>WS Form H-6</b>	<b>Report of Defective Radiosondes</b>
<b>WS Form H-14</b>	<b>Equipment Return Tag</b>

5. Documents Required to be on Station: The following documents and reference manuals should be at each upper-air site.

- a. FMH-3 dated May 1997
- b. MicroART Training Guide dated February 1999 or RRS User Guide dated October 2005
- c. NWSM 10-1401, Rawinsonde Observations
- d. Station Duty Manual

WSH will be responsible for providing updated instructions as warranted. If the instructions are in error or require updating, notify your Regional Upper-Air Program Manager. If the regional office determines that your suggested change is valid, it will be forwarded to WSH for review and possible inclusion in future updates.

## APPENDIX J - STATION MANAGEMENT

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1. Introduction: It is the site supervisor's overall responsibility to ensure all aspects of the station's operations run smoothly. This includes the upper-air program. Persons assigned to a site without an upper-air program, but required to inspect an upper-air site must have a good

understanding of current upper-air practices and procedures. Station management of the upper-air program includes the following:

- a. Adhering to current upper air policy and procedures.
- b. Training and certification of personnel.
- c. Data quality and timely dissemination of products and information.
- d. Safety of personnel and care of equipment.
- e. Ordering supplies and expendables.
- f. Ensuring accurate station data information.

2. WS Form B-48, Station Inspection Checklist: This checklist is an excellent tool to evaluate a site's upper-air program. The WS Form B-48 station inspection checklist serves a dual purpose. It allows the site to do a self-inspection of their upper-air operations and correct deficiencies. The inspection checklist is also used by national and regional personnel when visiting an upper-air site to ensure the site is following established procedures and guidelines. The form has been designed to promote uniformity in the site inspection procedures to ensure each site knows what is expected and what areas should and will be checked routinely.

2.1 Completion of WS Form B-48:

- a. Each site should use the checklist to perform a self-inspection once every 12 months. Deficiencies should be corrected immediately.
- b. Regional personnel should visit each upper-air site at least once every 18 months and use the form in conjunction with the (WS Form B-33 **may change**) to assess the station's overall performance.

2.2 Retention of WS Form B-48 and (WS Form B-33 **may change**): Sites performing a self-inspection should retain a copy of the WS Form B-48 for at least 3 years or after there have been two additional upper-air inspections by regional or national personnel. Station assistance visits performed by NWS Headquarters or station inspections performed by regional personnel should provide a copy of the WS Form B-48 to station management prior to leaving the station. A meeting and discussion of the issues should be completed to ensure the site personnel have a clear understanding of the issues and areas that require attention. The (WS Form B-33) should be retained on site for a minimum of 2 years.

3. Equipment Operation: It is the responsibility of the site supervisor to ensure that the equipment is operating properly. This involves keeping the electronics staff notified of equipment problems and properly documenting deficiencies or outages on a WS Form A-26, Equipment Outage Log. Each observer should check the equipment prior to and during each upper-air flight. If an equipment problem affects the performance of the flight or causes a loss of

data a WS Form A-26 will be completed in either electronic format or hard copy and given to the electronics staff.

Besides the notification of equipment problems, an inspection of the inflation building is important to maintain safety at the site. This, along with checking the accuracy of the equipment, is required to run a successful upper air operation.

3.1 Using the Theodolite: The optical theodolite is required for all sites using RDF tracking equipment. The theodolite serves several purposes. Initially, the theodolite is used to determine limiting angles at the sites. The limiting-angle diagram that is gained from using the theodolite to sight on obstructions along the horizon provides an accurate idea of when winds at a given azimuth and elevation will become inaccurate and should be considered missing. The theodolite also serves to ensure the tracking equipment is operating properly. This is accomplished by optically sighting a balloon and tracking it at the same time the tracking equipment follows the signal. The readings are synchronized and taken each minute of the flight. The readings are compared to verify if the tracking equipment is aligned properly or needs adjustment.

3.2 Limiting Angle Zone: The limiting-angle zone for NWS sites will be regarded as 6 degrees in elevation above the horizon or above objects, except trees, on the horizon. In azimuth, the zone extends 6 degrees from each side of the object. In the case of trees that extend more than 6 degrees in elevation above the horizon, the limiting- angle zone will extend in elevation to an angle that just clears the top of the tree or trees, and in azimuth to the edge of the tree or trees.

3.2.1 Accuracy of Data: The accuracy of the GMD and WBRT tracking is seriously affected whenever the elevation-angle readings fall within the limiting-angle zone, the boundaries of which vary with the individual site installation. Wind data computed from elevation-angle readings outside the limiting-angle zone will usually be regarded as accurate. No wind data will be computed from elevation-angles that fall within the limiting-angle zone.

3.2.2 Obtaining Limiting-Angle Data: Set up the theodolite as near as possible to the rawin set at approximately the same height as the center of the antenna. Carefully level and orient the theodolite to true North.

- a. The observer should at a minimum, note and record on a plain sheet of paper the elevation angle of the horizon or objects in the line of sight for each 10 degrees azimuth. For obstructions, such as trees, power lines, guy wires, and antennas, note a sufficient number of additional azimuth and elevation angle readings so that the shape of the obstruction, as seen by the antenna, can be approximated. Include the distance in feet to the obstruction.
- b. Sites may then use a WS Form B-38 or a sheet of cross-section paper to plot the horizon. All elevation heights read should have 6 degrees added to the reading and the azimuth readings should have 6 degrees placed on each side of the readings. The only exception is trees, which should not have 6 degrees added to either the elevation or to the either side of the azimuth.



**Note:** No reading should have a value less than 6 degrees.

- c. After the limiting angle diagram is completed, the data should be entered into the MicroART computer by going into the “Station Data” screen and entering the elevation angles to the nearest 0.1 of a degree at the appropriate azimuth angle. When the data is entered the observer may then request a plot of the limiting-angle information and save it to the station.dat file on both the hard drive and a floppy diskette.

**3.2.3 Updating Site Limiting-Angle Information:** Stations should update their limiting-angle diagrams every 5 years or sooner if necessary. Construction of new buildings or cutting of trees are common reasons to update the limiting-angle diagram on a more frequent basis.

**3.2.4 Disposition of Limiting-Angle Information:** At least two copies of the current MicroART station.dat diskette will be kept on station. One copy will be safeguarded and another will be accessible to the staff in case the file on the hard drive becomes corrupted. Additional copies of the station.dat file will be sent to the Regional Upper-Air Program Manager, the Upper-Air Program Office at NWS Headquarters, and to NCDC. The copies at the region and at NWS Headquarters will be used to either rework or resume flights to investigate field problems. The copy at NCDC will be used to ensure accurate site records.

**3.3 General Theodolite Test:** General theodolite tests will be performed upon receipt of a new or reconditioned theodolite and quarterly thereafter. When the theodolite is set up, leveled and oriented, sight on a target object and record the indicated elevation and azimuth angles. Adjust the theodolite by 180 degrees in both the elevation and azimuth angles then move the theodolite back on the original target object and record the angles. If the resulting differences are more than 0.2 degrees in either azimuth or elevation, the observer should repeat the test. If the differences in either angle are again out of tolerance, another observer should attempt the test, and if the results are outside the allowable 0.2 degree range, the theodolite should be returned to NRC and another theodolite ordered from NLSC.

Readings should be placed on the WS Form B-29 in the blocks labeled “Theodolite General Test”. The currency of this test and optical comparisons will be used in the final evaluation of upper-air site performance or awards.

**3.4 Optical Theodolite Comparisons:**

**3.4.1 Purpose of Taking Optical Comparisons:** Optical comparison should be performed at least once a quarter unless a Regional Operational Letter has been approved allowing a change to this policy. Optical comparisons are taken to ensure the radiosonde tracking equipment is operating properly and tracking smoothly.

**NOTE:** Optical comparisons are not required for GPS tracking systems.

**3.4.2 Procedures for Taking an Optical Comparison:** Optical theodolite readings are usually taken from a location within 125 feet from where the RDF tracking equipment is located. The

theodolite must be orientated using a minimum of two surveyed points within 400 feet of the theodolite. The theodolite must be level and properly oriented. Procedures for leveling and orienting the theodolite should be followed using the instructions in FMH-3, chapter 6, page 6-6.

It is best to do the comparison on a clear day with some wind. Days with strong winds which may cause limiting angles and days with light winds that may cause elevation angles above 60 degrees should be avoided.

The pibal timer should be started when the release is initiated. It is extremely important that it is synchronized with the time of release. The optical readings will be compared to the readings automatically recorded each minute as entered by the MicroART software when tracking the balloon. The timer buzzer will sound 10 seconds prior to each minute. This 10 second warning is provided to alert the observer to get the balloon in the theodolite cross hairs and be prepared to take an accurate reading at the next sounding of the buzzer.

The observer should attempt to lock-on to the balloon as early as possible using the sights mounted on top of the telescope and enter the angular readings on the WS Form B-17. Readings will not be used for the first 10 minutes of the flight due to rapid changes in the angular readings. Conditions for reliable readings must have elevation angles above the limiting angles and less than 60 degrees.

Readings used in the computation will not begin until the eleventh minute after release. Readings should be taken for at least 30 minutes from that time. Azimuth angles should be read every minute, but compared only every 5 minutes. The emphasis of the comparison is on elevation angles. The elevation angles should be read and compared every minute. The WS Form B-17 should have the optical theodolite readings entered and have the differences noted with the radiosonde tracking equipment's readings.

- a. Differences in azimuth readings will be entered every 5 minutes in column 3 subtracting the rawinsonde tracking equipment readings from the theodolite readings.
- b. Differences in the elevation readings will be entered each minute in column 5. Ground tracking equipment readings will be subtracted from the theodolite readings.
- c. Minute to minute changes will be entered in column 6. These readings will begin with subtracting the elevation difference recorded in column 5 starting at minute 11 from the minute 12 elevation difference. This process of subtracting the previous minute's angular readings from the next indicates the smoothness of the tracking.
- d. Column 7 is the square of the entries in column 6. These entries are tabulated for all minutes that have elevation readings between the limiting angles and 60 degrees. These readings when added together and divided by the number of entries in column 7 provide an average change. The observer should then go to

the “Table of Average Root Mean Squares” and locate the appropriate column that contains the average change. The average RMS value is shown to the right and should be placed in column c.

**3.4.3 Reporting RMS Values and Corrective Action:** The RMS values should be reported on the next WS Form B-29 in the blocks labeled Rawin-Rabal Comparison. The latest RMS value along with the date of completion should be entered. The following actions will be taken if RMS values fall within a given value.

- a. Whenever the RMS value is 0.050 or less:
  - 1). The electronics technician should examine the forms to determine the need for maintenance, and initial the forms after which they will be forwarded to the regional headquarters with the current WS Form B-29.
  - 2). If the electronics technician is expected to be absent from the station for more than 7 days, the forms will be forwarded without initials to the regional headquarters with the current WS Form B-29.
- b. Whenever the RMS value is greater than 0.050, hold the forms at the station until corrective action has been taken. After the action is completed, send the forms to the regional headquarters with the current WS Form B-29. If the RMS is between 0.050 and 0.080 and the station electronics technician is unable to complete corrective action within ten days, that fact, together with the reason for the delay, will be reported by email to the regional headquarters with a copy of the email placed in the station’s maintenance records.
- c. Whenever the RMS value exceeds 0.080, emergency maintenance is required. If the station electronics technician is unable to take immediate corrective action to reduce the RMS to less than 0.050, the regional headquarters should be notified.

**3.4.4 Disposition of the WS Form B-17:** Copies of the WS Form B-17 should be sent to the regional headquarters. If corrective action is required, the form should not be sent until the correction has been completed. A copy of the WS Form B-17 should remain on station a minimum of 3 years. This form, with other upper-air documentation, will be reviewed during upper-air site inspections from regional and national headquarters personnel.

**4. Initial Certification of New Personnel:** Certification involves three requirements. First, the person must demonstrate proficiency to the satisfaction of the site supervisor. Second, the person must pass a closed book examination with a minimum passing score of 80%. Third, the person must pass a vision test or bring proof of corrected vision of 20/30 or better. The Snellen vision test should be used on site unless proof of visual acuity is provided from a certified optician or ophthalmologist. The Snellen Vision Chart may be obtained from (NLSC). Its ASN number is YTA-B-028A. These requirements are for persons without a current upper-air certification.

It must be emphasized that all NWS Upper-Air operating systems require operator intervention. The observer must know how to perform routine and non-routine functions. This includes performing pre-release and in-flight actions to maintain a high success rate. The observer is expected to know how to edit and quality control data. This includes routinely checking and correcting software call-ups.

The regions may grant observers temporary authority to take upper-air observations under unusual situations not to exceed 60 days. Immediate steps should then be taken to formally certify observers in this category before the 60-day expiration period. This certification waiver should only be used in extreme circumstances. Requests granted by the regions must be forwarded to the NWS Upper-Air Program Office for record keeping purposes.

4.1 Request for Observer Examination: Request for the upper air examination may be made using WS Form B-25, the Request for Observer's Examination or Certification. This form may also be used to validate or invalidate a certificate. This is typically sent to the Regional Upper-Air Program Manager by the site supervisor. The submission of the WS Form B-25 is optional, and is at the region's discretion. Email notification or other means by the field site to the Regional Upper-Air Program Manager is the region's discretion.

4.2 Examination Requirements: Precautions will be taken to ensure the security of the certification examination. No portion of the examination will be copied without approval of WSH. All initial examinations are to be taken closed book and field supervisors should designate responsible proctors. All examinations will have a 2 hour time limit, with completion in one session. Currently certified observers becoming re-certified with RRS must take a proctored open book certification exam. The exam must be completed within a 2 hour limit. The observer must also demonstrate proficiency in required tasks and take a minimum of three live flights with a RRS certified observer prior to being certified for RRS observations. If an observer fails to make a passing grade, another certification examination may be given to the observer after two weeks of additional training and instruction. Requests for grade changes due to ambiguous test questions will be forwarded through the Regional Upper-Air Program Manager to the NWS Upper-Air Program Office.

The NWS Regional Directors and the NWS International Activities Office including persons they may designate will certify all observers who meet the qualifications. WS Form 10-1304-1, "Certificate of Authority to take Weather Observations," will be used to document certification.

4.3 Recency of Experience: An observer will take and record at least one complete upper air observation every 90 days. Persons involved in the daily use of upper air observations, training of upper-air personnel, or supervision of the upper-air program are exempt from the 90 day requirement. However, these personnel must have passed the upper-air certification at some point in their weather service career.

4.4 Lapsed Certificate: A temporary suspension of the certificate's validity may be caused by failure to revalidate within 90 days of transfer, degradation of an observer's eyesight, failure to maintain recency of experience, or poor observer performance. A lapsed certificate may be reinstated by the issuing authority upon the recommendation of the field supervisor when

conditions causing the temporary suspension have been corrected.

4.5 Canceled Certificate: This action revokes the certificates validity. Certificates are canceled when:

- a. Observer's terminate employment.
- b. A certificate has lapsed for 90 consecutive days.
- c. An observer fails to maintain the certification qualification as stated in this appendix.

A record of canceled certificates will be maintained by the regions. Each canceled certificate will be maintained for a minimum of 2 years, and then destroyed. In the event of litigation, the certificate or record will be retained for an additional 2 years after the completion of the litigation, then destroyed.

4.6 Validation upon Transfer: Personnel certified to take upper air observations must receive a new certificate from the gaining region if transferring outside the region. The field supervisor has 46 days from the time of arrival at the new station for personnel to demonstrate proficiency and have their certificate recertified with the gaining region. Certificates not validated and/or reissued by issuing authority within this time frame become lapsed. An observer with a lapsed certificate may not take official upper-air observations.

4.7 Vision Requirements: Persons certified to take upper-air observations must be able to visually find the balloon and adjust the tracking antenna after release. This task plus visually checking prior to making a release for aircraft or obstructions, requires the observer to have good visual acuity.

A Snellen Test Chart measuring 24 x 11 inches should be used. There should be adequate illumination. The chart should be 20 feet from the person being tested. Each eye should be examined separately with the other covered by an opaque shield. The row of smallest letters read by the person determines the denominator of the fraction used to grade visual acuity. The numerator is always 20: e.g. 20/20, 20/30, 20/40. If no more than two letters are missed in a line, the visual acuity will be graded as of that line.

- a. Distant vision of not less than 20/30 (Snellen) in the better eye, corrected if necessary
- b. Near vision, corrected if necessary, that meets the Jaeger #2 standard.

4.8 Changes in Radiosonde Types: An observer with a current upper-air certificate transferring to a site using a different instrument will be required to take an open-book exam. This examination will deal with specific questions relating to the new type instrument. This will also be the case for certified observers switching from RDF to GPS radiosondes.

It is the site supervisor's responsibility to ensure all observers certified to take upper-air observations are proficient in handling routine situations and know the availability of resources and reference material to resolve unexpected difficulties. All observers must take a minimum of three live flights with a certified observer prior to being certified or certified with another instrument.

5. Ordering Upper-Air Supplies and Expendables: Usually the site supervisor will assign a focal point to handle ordering supplies and expendables for the upper-air program. The only exception is that radiosondes are ordered, shipped, and paid by WSH. Other expendables will be ordered through NLSC. Sites ordering expendables from sources other than NLSC will have permission from the regional or national headquarters upper-air staff.

Sites should maintain at a minimum, a 3 to 4 month inventory for all supplies. This should allow enough time for shipments to arrive without the operations being effected. NLSC has a maximum shipping authorization on certain stock; sites will not attempt to circumvent this by stockpiling unrealistic quantities.

The following are stock items commonly ordered from NLSC in support of the upper-air program. These items and other items used in the upper-air program may be ordered using Engineering Handbook #1, Chapters G, J, M, P, B, X and Y.

ITEMS	ASN	UNIT OF ISSUE	COST
<b>EXPENDABLES:</b>			
Vaisala RS-80H Radiosonde	J030-1	BX (50)	N/C
Sippican VIZ B2 Radiosonde	J031-1	BX (16)	N/C
Sippican Mark IIA GPS Radiosonde	J031-2	BX (24)	N/C
Internet GPS Radiosonde	J034-1	BX (24)	N/C
26KM GP Balloons	J352-4	EA	\$ 31.49
30KM GP Balloons	J352-6	EA	\$ 34.30
26KM HM Balloons	J353-1	EA	\$ N/A
30KM HM Balloons	J353-2	EA	\$ 37.00
Parachutes	J390	PG (16)	\$ 67.00
Train Regulator	J382-2	BX (50)	\$ 530.30
Dereeler	J382-1	BX (50)	\$ 142.03
White Light Stick	J360-1	BX (10)	\$ 7.96
ITEMS	ASN	UNIT OF ISSUE	COST
Yellow Light Stick	J360-2	BX (10)	\$ 8.00
Green Light Stick	J360-3	BX (10)	\$ 8.51
Orange Light Stick (High-Intensity)	J360-4	BX (10)	\$ 9.63
Twine	J380-1	RO	\$ 2.65

#### UPPER-AIR EQUIPMENT:

VIZ Power/Supply Battery Tester	J208	EA	\$ N/A
Vaisala Battery Tester	J208-3	EA	\$ 98.75
Pibal Timer	J611	EA	\$ 783.13
Theodolite	J600	EA	\$ 604.50
Lifting Platform	J407-2	EA	\$ 913.60
Hydrogen Regulator	J412	EA	\$ 163.24
Multi-Stage Regulator	J411	EA	\$ 341.00
Hydrogen Safety Valve	J407-14	EA	\$ 388.83
Inflation Hose (Cut to Length)	J411-8	FT	\$ 2.19
Inflation Hose (6 Foot Length)	J411-7A	EA	\$ 14.35
Inflation Hose (60 Foot Length)	J411-7B	EA	\$ 272.52
Balloon to Nozzle Clamp	J421-2A	EA	\$ 13.46
Spark-Proof Scissors (Ceramic)	J422-1	EA	\$ 57.48
Gas Leak Detector (Snoop)	J422-2	BT	\$ 3.00
Inflation Weight Set	J430	EA	\$ 108.42
1,000 Gram Base Weight	J430-1	EA	\$ 91.90
1,000 Gram Weight	J430-2	EA	\$ 36.40
500 Gram Weight	J430-3	EA	\$ 33.60
200 Gram Weight	J430-4	EA	\$ 25.13
100 Gram Weight	J430-5	EA	\$ 26.40
Launch Area CDU	J700-1A3A11	EA	\$ 4672.00

## COMPUTER PARTS:

RRS Workstation	J700-2A3A1	EA	\$ 1992.00
IBM-XT	M003-1	EA	\$ 491.00
Monitor (Color)	M003-2	EA	\$ 190.71
IBM Keyboard	M003-3	EA	\$ 81.85
Hard Drive (20 MB)	M003-1A3	EA	\$ 44.00
SPU-11 Board	M003-1A1A4	EA	\$ 6093.33
Floppy Drive	M003-1A2	EA	\$ 96.54
Arctic Card	M003-1A1A1	EA	\$ 432.86
Color Graphics Card	M003-1A1A2	EA	\$ 90.78
Six Pak Plus Board	M020-32A11	EA	\$ 167.00
SPU-11 Interface	M003-7	EA	\$ 87.30
Smart Modem, Hayes Type 300	M003-6	EA	\$ 79.70

ITEMS	ASN	UNIT OF ISSUE	COST
Epson LX-300 Printer	B343-2	EA	\$ 190.26

## SAFETY SIGNS AND POSTERS:

Sign, Danger Hydrogen -No Smoking 25 Feet	P810-3	EA	\$ 25.08
Set, 5 Posters Inside Infl. Bldg	P810-4	EA	\$ 8.65

Gen. Rules Hydrogen Fire	P810-4A	EA	\$ 2.45
U/A Hydrogen Cylinder Safety	P810-4B	EA	\$ 2.45
Balloon Rupture	P810-4C	EA	\$ 2.45
Hydrogen-Fed Fire	P810-4D	EA	\$ 2.45
Non-Hydrogen Fire	P810-4E	EA	\$ 2.45
Sign, Security - Property of DOC/NOAA/NWS - 20 x 6 Inches	P811-1	EA	\$ 4.63

**MISCELLANEOUS:**

Station Inspection Report	YWS-B-33	EA	\$ 0.00
Upper-Air Program Review Guide	WS-B-48	PK	\$ 0.00
Convective Cloud Height Diagram	YTA-B-0-8	EA	\$ 0.00
Obstructions Above the Horizon	YWS-A-5A	EA	\$ 0.00
Snellen Eye Chart	YTA-B-0-28AEA		\$ 0.00
Jaeger Eye Chart	YTA-B-0-28BEA		\$ 0.00
Brass Non-Sparking Wrench	041-W-25	EA	\$ 73.28
First Aid Kit, Wall Mounted	060-H-1	EA	\$ 30.37
Eye Wash Station	060-E-1	EA	\$ 450.14
Eye Wash St. Preservative	060-E-4	EA	\$ 6.16
Anti-Static Mat 36" x 48"	060-M-3	EA	\$ 146.05

**OBSERVING EQUIPMENT:**

Precision Digital Barometer	G395	EA	\$ 9055.91
Remote Processing Unit	J700-4A1	EA	\$ 1449.00
Temp/Humidity Sensor	J700-4A2	EA	\$ 2076.00
Wind Sensor	J700-4A3	EA	\$ 2753.88
Base Station	J700-4A4	EA	\$ 3653.00

6. Accurate Station Data Information: It is essential that station data information be accurate and up to date. This information includes the following:

- a. Latitude and longitude to the nearest second for the baseline and release points. Obtain from site surveys, blueprints and station information and description pages.
- b. Determine elevation to the nearest 0.1 meter for the baseline and release point. Baseline elevation is where the instrument is baselined. This height is also where the Precision Digital Barometer (PDB) should be kept. Release point height is considered 4 feet or 1.2 meters above the height of the inflation building floor. The station pressure must be corrected for difference in elevation of the baseline point and the release point. See Table H-1.
- c. There are no baseline and release point height differences of 16 to 25 meters. This is because there are no NWS sites with height differences within this range.



<b>Pressure Correction in hPa Applied to Radiosonde Baseline Station Pressure</b>							
Barometer Height Minus Release Point Height (m)	<b>Barometer Elevation in Meters Mean Sea Level</b>						
	-5 to 299.4	299.5-599.4	599.5-899.4	899.5-1199.4	1199.5-1499.4	1499.5-1799.4	1799.5-2199.4
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3	0.4	0.3	0.3	0.3	0.3	0.3	0.3
4	0.5	0.5	0.4	0.4	0.4	0.4	0.4
5	0.6	0.6	0.6	0.6	0.5	0.5	0.5
6	0.7	0.7	0.7	0.7	0.6	0.6	0.6
7	0.8	0.8	0.8	0.8	0.7	0.7	0.7
8	0.9	0.9	0.9	0.9	0.8	0.8	0.8
9	1.1	1.1	1.0	1.0	1.0	0.9	0.9
10	1.2	1.2	1.1	1.1	1.1	1.0	1.0
11	1.3	1.3	1.2	1.2	1.2	1.1	1.1
12	1.4	1.4	1.3	1.3	1.3	1.2	1.2
13	1.6	1.5	1.5	1.4	1.4	1.3	1.3
14	1.7	1.6	1.6	1.5	1.5	1.4	1.4
15	1.8	1.7	1.7	1.7	1.6	1.5	1.5
26	3.1	3.0	2.9	2.8	2.7	2.7	2.6
27	3.2	3.1	3.0	2.9	2.8	2.8	2.7
28	3.3	3.2	3.1	3.0	3.0	2.9	2.8
29	3.4	3.3	3.2	3.2	3.1	3.0	2.9
30	3.6	3.5	3.4	3.3	3.2	3.1	3.0

Table J-1 - Pressure Correction for Difference in Baseline and Release Point Heights

- Notes:**
- 1). Add 4 feet to the inflation buildings floor.
  - 2). Converting to meters, multiply the height in feet by 3.28.
  - 3). **Elevation height in “Station Data Entry” screen of MicroART is at the release point.**
  - 4). MicroART limits entry of latitude and longitude to the nearest minute and elevation to the nearest meter. However, the RRS workstation will allow entries of latitude and longitude to the nearest tenth of a second and

heights to 0.1 meters.

- 5). WMO, WBAN, and SID must be kept current and up to date.
- 6). Primary and backup communication lines change and must be tested for functionality at regular intervals.

DRAFT

## APPENDIX K - STATION SAFETY

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1. Introduction: Safety is a vital part of the Upper-Air Program. Each site will have the required safety equipment and documentation on station. The site supervisor is responsible to ensure that proper safety procedures and practices are being followed. This emphasis on maintaining a safe work environment is especially important at sites using hydrogen or natural gas for inflation.

2. WS Form B-48, Station Inspection Checklist: The WS Form B-48, the Upper-Air Program Review Guide is an excellent starting place for the site supervisor to ensure safety guidelines are being met. Section VII, of the checklist provides a list of items typically checked during an upper-air site inspection. The WS Form B-48 also has a list of references after the

checklist if additional information is desired.

3. Upper-Air Safety Issues Inside the Office: These tasks inside the office need to be performed to ensure the upper-air program's safety:

- a. A posting of the location of wires, antennas, and other obstructions throughout a 360 degree circle within a 1/4 mile of the launch site. This chart will be prominently posted by the upper-air workstation inside the office. The station manager should advise all the staff of the inherent dangers of trying to disentangle a flight train from wires of any kind that carry an electrical current.
- b. Preparation of the water-activated batteries will follow the manufacturer's instructions. Care will be exercised not to allow battery solution to drip or spill on personnel or equipment. If solution should spill on the skin of the observer, the area should be flushed immediately with clean running water.

4. The Upper-Air Inflation Building: The upper-air inflation building is where most of the items dealing with safety are based. Responsibility for safety lies with all on-site personnel. A qualified technician will, at a minimum of every 6 months, check and document a safety check of the equipment to see that it is in safe operating condition and grounded properly. The observers will do a visual inspection of the inflation building and inflation room prior to and during the inflation process. The site supervisor should stay alert to issues that need attention and act promptly to ensure problems are resolved.

4.1 Generic Safety Issues for All Inflation Sites: There are generic aspects with the inspection of the inflation building that are common to both hydrogen and helium sites. There are also items that pertain strictly to hydrogen sites.

4.1.1 Outside the Inflation Building: The following items will be routinely checked outside the inflation building:

- a. The area surrounding the inflation building should be clear of obstacles and be level to allow the observer an environment that is safe to launch the balloon.
- b. The areas around the overhead doors and side doors should be free of ice and snow. Salt or ice melting particles will be available in case of icy conditions.
- c. The building, when not in use, should have all doors locked to ensure unauthorized persons do not have access to the area.
- d. The foot and hand railings will be secure and sturdy. A foot rail or kick plate should be installed at the top of the stairs leading up to the radome to eliminate the potential of personnel possibly slipping off or falling from the stairs during icy or slippery conditions (See Figure K-9 page K-10).
- e. All outside lights should work and the area should be well lit.

- f. A communication system is required and should be turned on prior to an individual going out to the inflation building. This is to ensure an open line of communication is kept with the office. This requirement is especially needed for launches during inclement weather and to ensure that if an observer is injured there is a means of calling for help.
- g. Overhead doors and louvers must be in good operational condition.
- h. Entrance to the stairwell leading to the top of the roof or radome will be either secured or have an “Authorized Personnel Only” sign chained across the stairs (See Figure K-7 page K-9).

4.1.2 Inside the Inflation Building: The following items are required inside the inflation building at all sites:

- a. The floor will be kept clean and free of debris.
- b. Approved fire extinguishers will be placed inside the inflation building and also inside the radome and inspected annually by a certified expert and visually inspected and initialed off monthly by station personnel.
- c. The inflation table will be clean and free of dirt.
- d. Expendable items stored in the inflation building will be stored within electrically grounded metal cabinets.
- e. The interior of the building will be well lit.
- f. The gas cylinders will be properly marked and secured individually or possibly in pairs to ensure they can not topple over (See Figures K-1 page K-6, and K-2 page K-7).
- g. Caps will be on all cylinders full and empty not connected to the supply line.
- h. Cylinders will be pre-positioned to keep personnel from moving cylinders themselves. (See Figure K-4 page K-8).
- i. Cylinders will not be manifolded. (Supply hose must feed off only a single cylinder). (See Figure K-6 page K-9 for unauthorized cylinder manifolding).
- j. First-aid kits will be available in the inflation building, the radome, and the hydrogen generator building.
- k. Spare UL approved regulator available.

- l. Fill rate follows NWS instructions.
- m. The poster for the “General Safety Rules for Cylinders” will be displayed in the cylinder storage area. The poster for “Non-Hydrogen Fire” will be displayed on the wall inside the inflation room (See Figure K-8 page K-10).

4.2 Hydrogen or Natural Gas Sites: The following rules apply to sites using hydrogen or natural gas:

- a. Only spark-proof tools will be used in and around a hydrogen environment. Brass tools are available through NLSC (See Figures K-10 and K-11 page K-11).
- b. Smoking or lighting of flammable materials will not be allowed within 25 feet of buildings where hydrogen gas is stored or generated. Each site will have signs prominently displayed on the exterior of each side of the inflation building saying “Danger Hydrogen - No Smoking Within 25 Feet”. These metal signs can be obtained through NLSC using ASN P810-3.
- c. All overhead door runners will be electrically grounded. Grounding can be accomplished by using a grounding wire and connecting it to a nearby grounding rod. The rollers will have a conductive lubricant applied at frequent intervals (See Figure K-3 page K-7).
- d. The hydrogen fill system including the inflation hose, nozzle, and inflation table will be grounded with the frame of the building and have a resistance of less than 25 ohms. (Resistance will be checked at least every 6 months by a qualified technician).
- e. An anti-static mat will be placed at the end of the inflation table where the observer stands during the process of attaching the balloon to the nozzle and tying of the balloon after inflation.
- f. Safety posters will be prominently displayed in the inflation room and cylinder storage area. These posters or signs are available through NLSC. The ASN range P810-4A through P810-4E. The entire set of 5 posters can be ordered using ASN P810-4 (See Figure K-8 page K-10).
  - 1). P810-4A - General rules for hydrogen fire prevention.
  - 2). P810-4B - Safety rules for hydrogen cylinders.
  - 3). P810-4C - Balloon rupture procedures.
  - 4). P810-4D - Hydrogen-fed fires.
  - 5). P810-4E - Non-hydrogen Fire.

- g. New personnel will not be allowed to work in and around hydrogen generators unless accompanied by a qualified operator. Each operator must be certified prior to working alone.
- h. All electrical switches, lights and wiring must meet the code or standards required by the National Fire Protection Association (NFPA) for hydrogen safety. This requires the installation of non-explosive designed wiring, lighting, and switches.
- i. Only a minimal amount of expendables will be stored inside the inflation building. Combustible expendables will be placed within a metal storage cabinet.
- j. At least 2 fire extinguishers will be placed in the inflation room. One of extinguishers will be at least 20 lbs and be placed near the exit. Additional 10 lb or larger extinguishers will be placed in the cylinder storage area and in the radome. The extinguishers will be inspected annually.
- k. Vents in the inflation building will be placed near the top of the inflation building and will be at a minimum of at least 1 square foot for each 1,000 cubic feet of space within the inflation building.
- l. Trash cans should be kept outside the inflation building. They should be metal and have a lid securely in place.
- m. Cylinders will be stored and transported in an upright condition. The cylinders will be secured individually or in pairs. Either a non-metallic chain or cable or a metal chain or cable with a plastic covering will be used to eliminate the potential for a spark (See Figure K-2 page K-7).
- n. A limited number of hydrogen cylinders will be stored on site. This should usually be limited to 15 cylinders. Exceptions to this will be approved by the Regional or National Safety Officer.
- o. Only approved dual stage hydrogen regulators, hoses, and equipment will be used. Engineering Handbook 1 lists authorized equipment stocked at NLSC (See Figure K-5 page K-8).
- p. Hydrogen cylinders will not be manifolded.
- q. In the event of a balloon rupture, the observer will carefully open the side door and the overhead door at least 18 inches to allow the area to ventilate properly. The observer will then walk outside the building and wait 15 minutes prior to beginning to fill another balloon.
- r. Devices used to heat the inflation building or the radome above the inflation building will meet Class I, division 2, Group B specifications in the NEC.

- s. Interior wiring, light switches, and light fixtures inside the inflation building will be explosion proof.

5. Safety Issues Prior to Release: The following should be followed prior to launching a balloon:

- a. Sites located within 5 nautical miles of an active runway for a controlled airport will contact the controlling authority and request permission to do a balloon release.
- b. At all sites, the observer will check the horizon to ensure there are no aircraft or other activity that the balloon might interfere or endanger. If aircraft or other activities are present, the observer will postpone the launch until it is safe to launch.

**Note:** The requirement for filing a Notice to Airmen (Notam) is no longer necessary. The radiosondes used by the NWS do not meet the size and weight requirements that demand a Notam be filed. This does not however, eliminate the requirement to request permission to launch or release if a site is located within 5 nm of an active runway at a controlled airfield.

6. Safety Photos:



Figure K-1 - Cylinders Secured Improperly





Figure K-2 - Properly Secured Cylinders

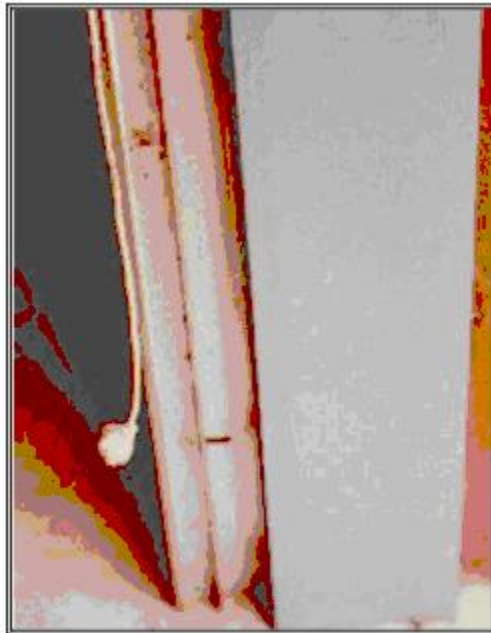


Figure K-3 - Ungrounded Overhead Door Railing



Figure K-4 - Cylinder Cart, Not Allowed



Figure K-5 - Unauthorized Hose



Figure K-6 - Unauthorized Manifolding of Cylinders



Figure K-7 - Authorized Personnel Only Sign & Hydrogen No Smoking



Figure K-8 - Safety Posters



Figure K-9 - Foot Plate at Top of Stairs



Figure K-10 - Brass Non-Sparking Wrenches

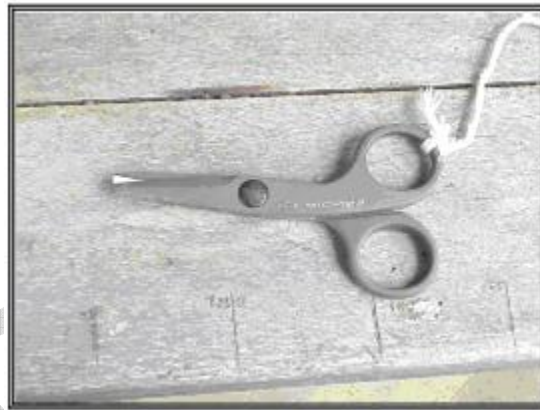


Figure K-11 - Ceramic Scissors

## APPENDIX L – RADIOSONDE SURFACE OBSERVING INSTRUMENT SYSTEM (RSOIS)

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1. **Introduction:** This appendix describes the Radiosonde Surface Observation System (RSOIS). The instructions should provide the user with additional information that may help in



better understanding how each component and the overall system operates.

The RSOIS gathers and reports data on weather parameters at the surface to be used in the analysis of the upper air data obtained during a balloon flight. In routine operations, the sensors mounted on a tower at the launch site, provide data to a processor in a metal enclosure also mounted on the tower is the Remote Processing Unit (RPU). The processor in turn feeds data to an rf modem (or fiber optic modem) housed in the same enclosure. **The data are transmitted to a unit called the Base Station where the weather observer can monitor the information.** The Base Station is a radio processor and LCD display housed in a single breadbox-sized unit.

2. RSOIS Sensors: The RSOIS provides temperature, dew point, relative humidity, wind speed, and wind direction readings. Pressure readings are gathered from the paroscientific digital barometer (PDB) located inside the office at the baseline location. Figure L-1 shows a typical RSOIS tower with the sensors identified.

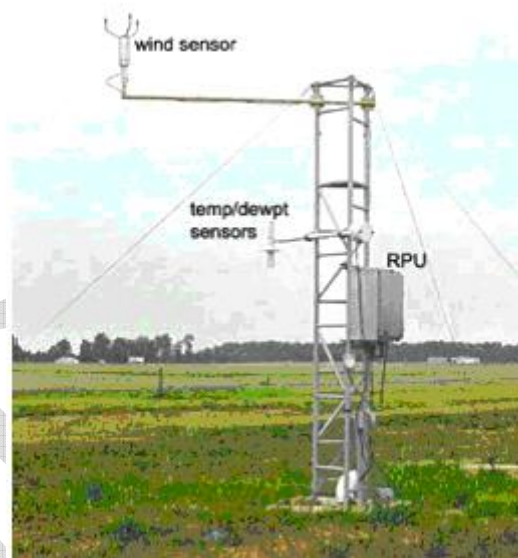


Figure L-1 – RSOIS Tower

2.1 Wind Sensor: The wind sensor provides wind speed and direction. The wind sensor does not depend on mechanical movements as do the traditional rotating-cup anemometers and wind vane direction indicators. Measurements of both averaged wind speed and direction are reported based on the transit times for ultrasound between the spikes of the wind sensor that are fixed in position. The wind sensor is a Vaisala/Handar 425AHW Ultrasonic Wind Sensor and is considered a 'smart' sensor.

It contains a microprocessor that computes the averages and every 5 seconds supplies:

- a 5-second average wind speed
- a 5-second average wind direction
- heater circuit quality and other data

The heater is thermostatically controlled and prevents freezing rain or snow buildup. It is positioned 10 meters above the ground.



Figure L-2 – Wind Sensor

2.2 Temperature/Humidity Sensor: The contained sensors are housed within a Gill Aspirated Radiation Shield which reduces radiation errors to less than  $0.1^{\circ}\text{C}$ . The sensors are located approximately 2 meters above the ground.

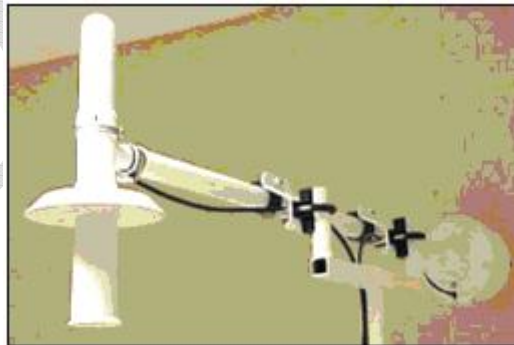


Figure L-3 – Temperature/Humidity Sensor



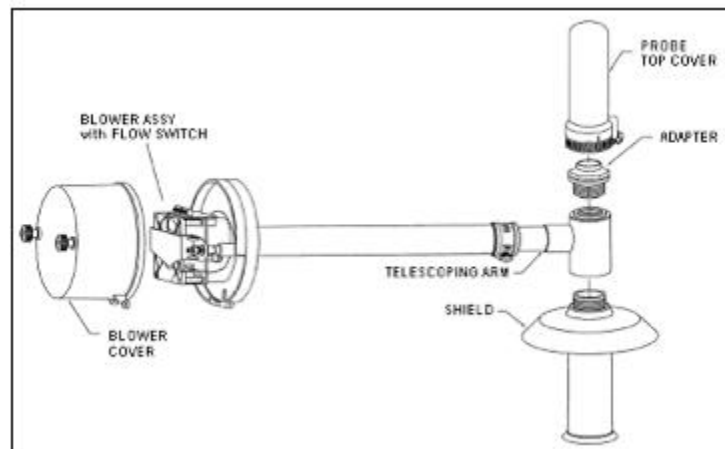


Figure L-4 – Expanded View of Components

### 2.3 Sensor Accuracy:

Temperature -  $\pm .2$  degree C      Dew point -  $\pm 2.0$  degree C      (5 Minute Average)

Relative Humidity -  $\pm 3\%$       (5 Minute Average)

Wind Direction -  $\pm 2$  degree      Wind Speed -  $\pm 3\%$       (2 Minute Average)

3. RSOIS Base Station: Readings are displayed on the RSOIS Base station on a Liquid Crystal Display (LCD). (See Figure L-5). If the base station is receiving data, the data light illuminates every 5 to 7 seconds.



Figure L-5 – RSOIS Base Station

### Wind Speed and Direction Readings:

**SP:** The current 2-minute average wind speed.

- GU:** Gust speed and refers to the max wind speed in the past 10 minutes.
- PK:** Indicates the peak 5 second wind speed in the past 2 minutes.
- WD:** Is the current 2-minute average wind direction.
- WC:** Is 0 for steady winds and set to 1 if the current wind speed is > 6 knots, and the total wind direction range in the current 2-minute average is 60 or more.

Temperature, Dew point and Relative Humidity Readings:

- AT:** Is the current 5-minute average temperature in °C.
- DP:** Is the current 5-minute average dew point temperature in °C.
- RH:** Is the current 5-minute average relative humidity by %.

4. Remote Processing Unit (RPU): The RPU, mounted on the tower, is housed in a stainless steel enclosure. When powered within a minute, the RPU should be collecting and transmitting data.



Figure L-6 – Remote Processing Unit (RPU)

- 4.1 RPU Components: The RPU contains:

- a. The SDL (System Data Logger)
- b. Power supply
- c. 12-volt backup battery
- d. Spread spectrum radio/
- e. fiber optic modem
- f. Sensor ports
- g. Zeno-3200 SDL controls the sensors, logs data, performs averaging, formatting

and other calculations, and controls communications. It does multi-tasking which allows simultaneous sensor sampling and communication.

- h. The backup power is provided by a 12 VDC, 38 amp-hour YUASA battery that independently powers the RSOIS for approximately 30 hours operation depending on temperature.

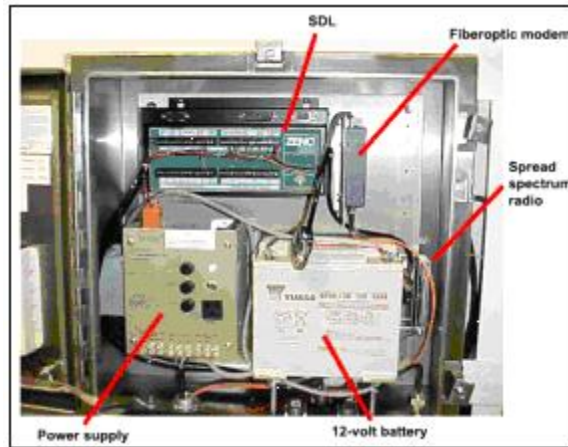


Figure L-7 – RPU Components

- i. Watchdog Timers- In remote electronic systems, it is possible that large electrical surges from sources such as excessive Strong Radio Transmissions (RFI) or lightning will scramble the software in the RAM or operating memory. In order to verify correct operation of the equipment, watchdog timers are built into the ZENO-3200.
- j. The system also contains software that examines data from the sensors to detect *common faults* and to ensure that the sensor is operating within range. If the sensor readings should fail any of their tests, an alarm message is logged and transmitted with the next data transmission.

*A 32-bit Built-In-Test (BIT) field is used to convey information on a large number of warnings.*

Other ZENO-3200 self-tests include:

Analog input zero-offset reading

EEPROM Read/Write status

Logging-memory status

System power

Internal temperature

Real-time clock

**Note:** The SDL's clock uses a 10-year lithium battery which is independent of the system backup battery. The clock is calibrated to give an accuracy of 5 seconds per month.

4.2 Cabling and Power: In routine operations the RPU is powered by AC entering through the base of the enclosure. This particular picture shows fiber optic cable that is used for communication with the base station. The RPU can support either radio communication or use of a fiber optic cable driver, but not both simultaneously. (See Figure L-8)

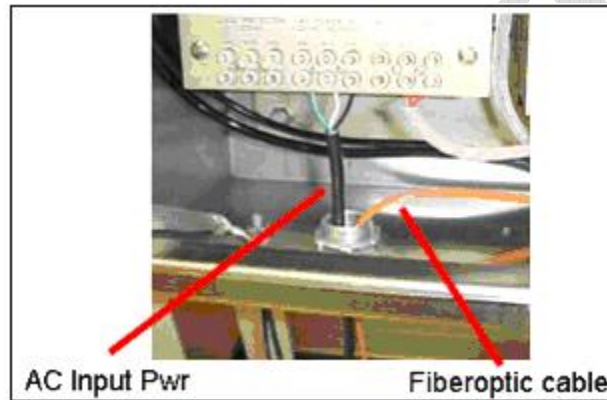


Figure L-8 – Power and Cabling

4.3 Lightning Protection: The lightning protection and diversion of the RPU is in addition to protection provided by the tower-mounted lightning rod.

*The system employs these levels:*

- a. The tower is connected as directly as possible to an earth grounding system.
- b. Induced currents are diverted to earth ground via the metallic electronics enclosure.
- c. Resistor-capacitor decoupling networks acting in concert with resistor-diode networks are built into each line entering sensitive semiconductor devices.

5. Antenna: The tower-mounted antenna at the RPU is a Yagi meant for the 2400-2483.5 MHz frequency band. It has a length of 7 1/4 inches. With a 60° horizontal beam width it can be aligned visually. Orientation accuracy should be within  $\pm 15^\circ$  to achieve maximum gain. The radio and antenna system provides up to 3 miles line-of-sight communications.



Figure L-9 - Yagi Antenna

6. RSOIS Siting: The RSOIS tower should be located within 200 meters of the radiosonde release point. It should be sited to provide readings that are free from effects of blocking from buildings or obstructions. It should be positioned away from blacktop or asphalt surfaces and over a grassy area.

**The RSOIS equipment is not to be used as an official backup to other observing systems. This observation system is strictly to be used with upper air observations.**

7. Maintenance: Routine and preventative maintenance is required. This system is an official National Weather Service (NWS) observing system. It is explained in Engineering Handbook 9-904.

Go to [FTP://140.90.24.7/RRS\\_Manuals\\_EHB\\_9/RSOIS](FTP://140.90.24.7/RRS_Manuals_EHB_9/RSOIS) In EHB9-201 look in Chapter 3 at Table 3-1 in EHB9-201)

Inspection	Service Action	Interval (months)
Verify that the wind sensor's orientation is within 1° of true north and within 2° of horizontal.	Adjust and align as needed.	12
Inspect the wind sensor bird spikes for damage.	Tighten as needed; replace bird spikes if necessary.	12
Inspect the wind sensor cable for damage.	Replace the wind sensor cable if necessary.	12
<b>Temperature/Humidity Unit</b>		
Inspect the temperature/humidity sensor filter. (More frequent inspection may be appropriate in some locations.)	Clean frame and replace filter as needed.	2
Inspect the cable connector for condition, tightness, and lubrication.	Clean and lubricate with dielectric grease; tighten as needed.	6
Compare the temperature/humidity sensor readings to aspirated psychrometer measurements.	Perform procedure; replace temperature/humidity probe if necessary.	6
Inspect the blower motor for condition and operation.	Clean as needed; replace blower motor if necessary.	6
Inspect the mounting brackets, clamps, and U-bolts for tightness.	Tighten as needed; replace hardware if necessary.	12
Inspect the integrity of the mounting adapter and split bushing.	Replace hardware if necessary.	12
Inspect the temperature/humidity sensor and cable for damage.	Replace temperature/humidity sensor if necessary.	12
Inspect the complete aspirated shield assembly; ensure that the skirt/shield, top cap/cover, and the blower assembly are not cracked or clogged.	Clean as needed; repair, and/or replace aspirated shield assembly if necessary.	12
Replace the temperature/humidity probe.	Remove temperature/humidity probe; replace with calibrated probe.	24
<b>Remote Processing Unit</b>		
Inspect the inside of the enclosure for moisture and condensation. (More frequent inspection may be appropriate in some locations.)	Remove moisture from inside enclosure and dry thoroughly as needed; replace desiccant.	3
Inspect the enclosure, door hinge, fittings, and connectors for damage or corrosion.	Clean and lubricate with dielectric compound; replace enclosure if necessary.	6
Inspect the rubber gasket along the inside edge of the enclosure door for wear or deterioration.	Clean with mild soap and water; rinse thoroughly. Replace enclosure if necessary.	6

Table L-1 – Preventive Maintenance Schedule for RSOIS

## APPENDIX M – SPECIAL SOUNDINGS

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<p>1. <u>Introduction:</u> Special soundings may be requested by Private enterprise and government agencies, on occasion. This appendix explains the approval, coordination and special project process to ensure proper documentation.</p> <p>2. <u>Administrative Responsibilities:</u></p> <p>2.1 <u>Weather Service Headquarters:</u> Each prospective sponsor must state in writing to the Director, Office of Services, the sponsors request for special soundings. The Special Projects Coordinator should review the request and may recommend NWS support. The Special Projects Coordinator should then coordinate and prepare the request in the form of a Memorandum of Agreement (MOA) and Reimbursable Task Plan (RTP). The documents will be submitted for the review and clearance of WSH or the Region. The responsibilities of WSH are to:</p> <ul style="list-style-type: none"> <li>a. Calculate total projected costs and coordinate with Region.</li> <li>b. Submit MOA for NWS clearance, and then coordinate MOA sign-off.</li> <li>c. Submit RTP (NOAA Form 32-25) and funds for NOAA Finance collection.</li> <li>d. Send Sponsor a disk (see Section 5 page M-3), named CONVERT, to read the</li> </ul>	



Store and Results files mailed by the field office. RRS sites will either FTP files or save to a CD for the sponsor.

- e. Coordinate with WSH and NOAA divisions to reimburse the Sponsor and Regions, as needed.

2.2 Regional Headquarters: Upon receiving a letter of request, the Region will inform WSH of the request. If Region and WSH agree, the Region should administer the special project. The Region should coordinate with field offices, prepare the MOA and RTP, and gain NWS Headquarters clearance. The Region then assumes the responsibilities listed in Section 2.1. For either WSH or Region prepared special projects, the Regional Upper-Air Manager will:

- a. Coordinate with the Field Office manager and determine if the office can schedule overtime and gain familiarity with terms of the generic Upper-Air MOA.
- b. Upon completion of Region-to-WSH coordination, the Region should send the WSH/Region Coordination Form, signed and dated, to the Special Projects Coordinator.
- c. Forward a copy of the RTP to the Regional Budget Officer (e.g., W/ER5).
- d. Mail one copy of the site's Form A-22 to the Special Projects Coordinator, WSH. The Field submits A-22s monthly, as needed.
- e. Ensure the Regional Budget Office prepares an 'Amended RTP' to account for the actual field labor and material expenses (remember to exclude the cost of radiosondes).

2.3 Local Office: The local office examines staff schedules to assess office's ability to accommodate the overtime work. The local office will handle all special soundings as routine operational flights concerning the naming, logging, transmitting, and archiving of upper-air observations and reporting rawinsonde performance. In addition, Form A-22, Report of Supplemental Observations, should be completed as described in Section 6 page M-3.

3. Types of Projects: The primary requesters are NOAA, NASA, state and local government agencies who conduct research studies. Other requesters include university and private corporations who conduct research and develop technology. About 40% of projects directly support research in atmospheric and hydrological sciences, about 30% support air chemistry analyses, and 30% support various industries' activities. A typical special project resembles this example.

**Project Name:** Southern Oxidants Study (SOS).

**Sponsoring Agency:** University of Alabama in Huntsville (UAH).

**Schedule Period:** August 1, 2005, thru August 31, 2005.



**Times of Specials:** 18 UTC soundings.

**Maximum Number of Specials:** 12 observations.

**Ascension Numbers Assigned:** Specials are assigned sequential ascension numbers.

**Coded Message Transmission:** All message parts (e.g., TTAA, TTBB, PPBB).

**Upper-Air Files to Mail:** Copy all **Store** and **Results** files to disk and mail to Sponsor.

**NCDC Archive Required:** MicroART flights; both the archive and 6-second store disks get archived. RRS flights; the .mdb files along with the compressed thermal, header, and bufr files will be archived.

MicroART sites will save the Store and Results files to a separate disk right after flight termination and then mail to the Sponsor no later than one week after the observation.

RRS sites will either FTP or send flights on a compact disk to the sponsor. Files will contain the .mdb files along with the thermal, header, and bufr files.

4 Special Project Costs: The total project cost can be calculated from two figures, the per-flight-cost (at overtime rate) and the administrative fee.

4.1 Overtime Authorization: Unless precluded by local station management, overtime is typically authorized to conduct special soundings.

4.2 Expendables: In nearly all cases, the site's common stock of radiosondes is used. On occasion, there might be a request to use special radiosondes, batteries, and associated equipment.

5. Disposition of Data and Archive Files: The NWS makes the data collected from the sounding available in the standard coded message format as soon as the message is generated. The flight data is treated as another routine observation. The file is saved for archive and ultimately sent to NCDC. The Sponsor, if using MicroART flight data, will use a Convert disk to change the Store and Results files to a readable text format (ASCII). RRS flight data does not require conversion.

6. Information Reported: Each WS Form A-22 should clearly document the special project. This form is useful for several reasons:

- a. It identifies the title and nature of the project.
- b. Shows the total number of special observations taken.
- c. Shows the total number of radiosondes used.

- d. Shows the release dates and times, with space provided for remarks on each flight.
- e. Shows the amount of overtime used per flight. This helps ensure Region is reimbursed for proper labor charges. (Maximum 3 hours overtime per flight is allowed)

7. When and Where to Submit WS Form A-22: The station is responsible for completing the WS Form A-22 each month that special flights are taken.

- a. The original WS Form A-22 is submitted to the Regional Upper-Air Program Manager with all pertinent information completed.
- b. A copy is submitted to:

National Weather Service Headquarters  
1325 East-West Highway  
SSMC2 Attn: OS7 Room 14164  
Silver Spring, Maryland 20910

Retain a copy on station for 12 months.

8. Timeline for Upper-Air Special Projects:

**T-4 Months** - Sponsor writes letter of request to Director, OCWWS.

**T-3 Months** - Regional Manager works the Special Project Coordination Form.

**T-3 Months** - General Counsel Weather (GCW) and NWS clear the MOA.

**T-2 Months** - NWS and Sponsor ratify the MOA and Sponsor makes advance payment.

**T-1 Month** - Special Projects Coordinator submits RTP to Finance and Budget.

**T-0 Month** - Project Starts.

**E+1 Month** - Special Projects Coordinator calculates total cost and informs Sponsor.

**E+2 Months** - Region receives the Amended RTP to execute labor and expendables budget.

**E+3 Months** - NOAA/NWS sends reimbursement check to Sponsor.

**End of FY** - WSH closes the assigned RTP task allocation (e.g., BM1JUA).

T = Denotes start of Period of Performance. E = Denotes end of Period of Performance.

DRAFT

## APPENDIX N – RADIOSONDE PREPARATION

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1. Introduction: This appendix describes the flight preparation procedures for the MkIIA GPS radiosonde. These instructions are also provided with each box of instruments. In brief, follow these radiosonde preparation tasks:

- a. Unpacking a radiosonde.
- b. Unpacking and positioning the radiosonde sensors.
- c. Selection of the appropriate frequency (1676 to 1682 MHz).

- d. Preparing the radiosonde battery for operation.
- e. Attaching a radiosonde to the dereeler and balloon.
- f. Release of the radiosondes.

2. MkIIA GPS Radiosonde Preparation: Use the following methods to prepare the GPS radiosondes:

- a. Carefully remove the MkIIA radiosonde from its packing material (See Figure N-1). Inspect for damage in shipping, missing components or tears in the cardboard sleeve.



Figure N-1 – Unpacked Radiosonde

- b. Remove the plastic cover from thermistor arm, unfold and orient the thermistor arm (See Figures N-2 and N-3 page N-3).

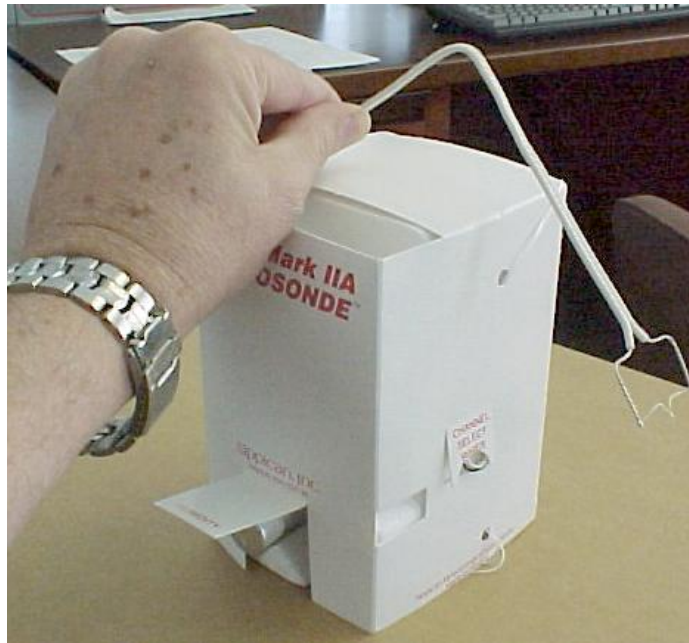


Figure N-2 – Unfolding Sensor Boom



Figure N-3 – Orienting Boom

**CAUTION:** *It is vital the sensor's boom be positioned as shown in Figure N-3. If the*

*temperature boom is not set correctly, erroneous temperatures will result.*

- c. Inspect the temperature sensor for broken leads or a chip bead. If leads are bent gently bend the leads back into place using a pen or pencil (See Figures N-4 and N-5).



Figure N-4 – Temperature Sensor



Figure N-5 – Lead Adjustment

- d. Remove the humidity sensor's protective cover. Twist the cover back and forth

while evenly pulling on the cover (See Figure N-6 page N-5). If necessary, use a pair of pliers to remove the cover. Inspect the hygristor, the black tape edges should be secure in the duct, and check for damage or defects. Orientation of the hygristor should be at an angle as shown in Figure N-7 page N-6. If the hygristor is perpendicular to the duct, the instrument should be rejected. Do not touch the hygristor surface; doing so will alter the sensor calibration or resistance values. Close the humidity flap and secure it using masking tape provided with the radiosonde to keep light and precipitation out.

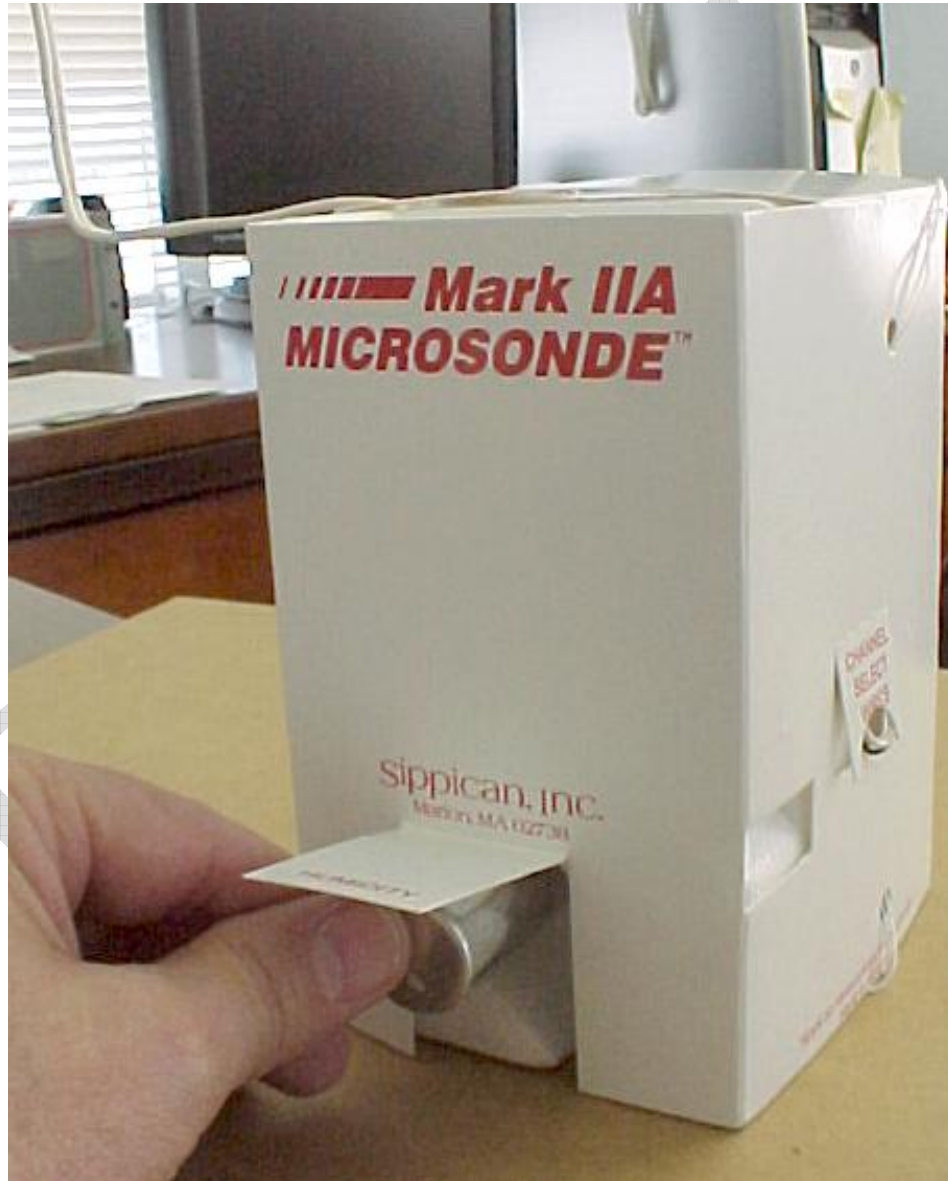


Figure N-6 – Humidity Cap Removal





Figure N-7 – Hygristor

- e. Setting the Frequency- The default transmitter frequency is 1676 MHz. Sites should use 1676 MHz unless there is an interference problem or an additional release is required. Table N-1 outlines the frequency channels available.

White	Black	1676	1678	1680	1682
Uncut	Uncut	X			
Uncut	Cut		X		
Cut	Uncut			X	
Cut	Cut				X

Table N-1 – Frequency Selection Chart

- f. Change the frequency by cutting the black and/or white wires located on the side opposite the deployed temperature sensor boom (See Figures N-8 and N-9 page N-7).



Figure N-8 – Set Frequency



Figure N-9 – Cut Wires

- g. Lift the flap in the back of the radiosonde sleeve cover to expose the battery (See Figure N-10).



Figure N-10 – Battery

- h. Remove the battery from the battery compartment.
- i. Remove the battery from the vacuum sealed foil bag. Inspect the battery for damage to the connectors or wires.
- j. Place the battery with the label facing upward (Top-Up position) in a container of tap water at 10 - 25 degree Celsius. The top of the battery should be covered by a minimum of one inch of water (See Figure N-11 page N-9).

**NOTE:** *In the label-up orientation, the battery will be positioned such that the wax layer on the opposite side will not trap air inside the cells while immersed in water.*

**CAUTION:** *Avoid getting the battery connector wet. Water in the connector may cause a short and significantly reduce the battery life and may result in the battery over-heating.*



Figure N-11 – Activation Water Container

- k. Leave the battery in the water for two minutes.

**NOTE:** *To avoid overheating or premature flight termination - The radiosonde should be released within 30 minutes of activation.*

- l. Use the following directions to remove the excess water from the battery:
- 1). Hold the battery in your hand wearing protective gloves and with the label facing down (Top-Down position).
  - 2). Extend your arm and then swing the battery in an arc starting over your head and stopping abruptly at your knees.

**NOTE:** *Orient the battery so that the label is facing away from your palm. This way the excess water will be thrown away from the battery and not be trapped by the wax layer on the opposite side of the battery.*

- 3). Repeat the swinging motion approximately 10 times.
- 4). Examine the partially waxed sides of the battery for remaining excess water in the unwaxed areas. Repeat steps 2 and 3 if you find excess water on the battery.

**CAUTION:** *Excess water greatly increases inter-cell leakage, causing overheating of the battery and shorter battery life.*

- m. Place the battery in the plastic bag provided with the carton of radiosondes.
- n. Twist the radiosonde battery connection wires counterclockwise four turns. Also, twist the connection wires on the battery four turns the opposite (clockwise) direction (See Figure N-12 page N-10).



Figure N-12 – Twist Battery Wires

- o. Place the battery in the radiosonde battery compartment such that the TOP label faces OUT of the compartment. By pushing the battery all the way into the bag and tucking the bag ends inside, the battery fits easier in the compartment.
- p. Connect the battery to the radiosonde battery connector. Connect the black or ground wire of the radiosonde to the black or ground lead of the battery (See Figures N-13 and N-14). Then connect the red or positive lead of the battery to the red or positive lead of the radiosonde.

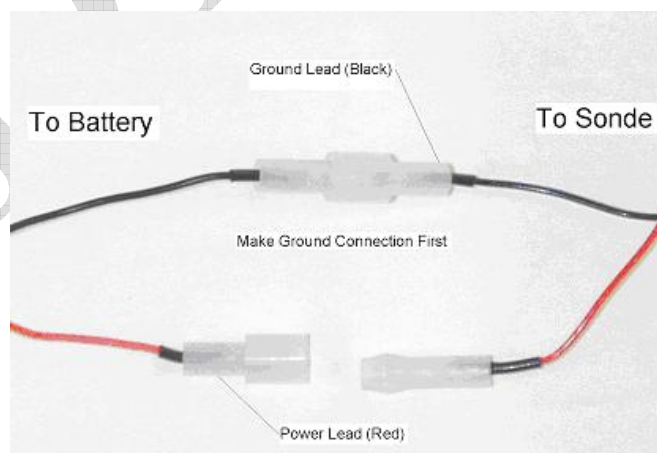


Figure N-13 – Connect the Ground Wires First

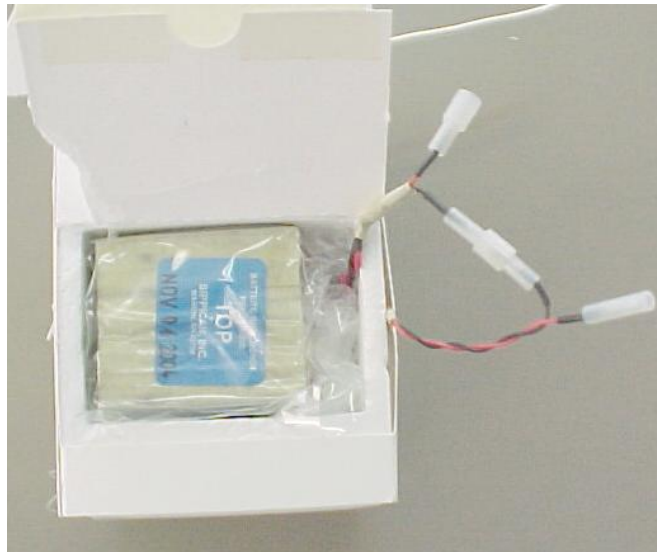


Figure N-14 – Connect the Wires First (Inside the Radiosonde)

**NOTE:** *In step p. (and Figure N-14), it is important to connect the ground on the radiosonde to the ground on the battery first. This is necessary for proper microprocessor start-up.*

- q. Tuck excess wire and the connector on the top or side of the battery inside the battery compartment (See Figure N-15).



Figure N-15 – Battery in Compartment

**NOTE:** *Failure to put all the battery wire inside the battery compartment may cause radio energy to feed back into the circuits of the radiosonde.*



- r. Close the flap over the battery compartment and tape it shut with the provided tape strips and masking tape used to pack the radiosonde inside its plastic bag.
- s. Apply the Station Information Label to the side of the radiosonde above the Channel Select Wires flap. This label is intended to eliminate the need for the observer to open the Return Mail Bag flap. The mail bag is extremely difficult to remove and replace (See Figures N-16 and N-17).

<b>HARMLESS WEATHER INSTRUMENT</b>		
RELEASED BY THE NOAA NATIONAL WEATHER SERVICE FROM:		
_____	on _____	and _____
Station Location (City, State)	Date	Time (UTC)
Please return this radiosonde instrument to the National Weather Service using the self-addressed prepaid mailbag provided under the perforated, removable side tab.		

Figure N-16 – Station Information Label

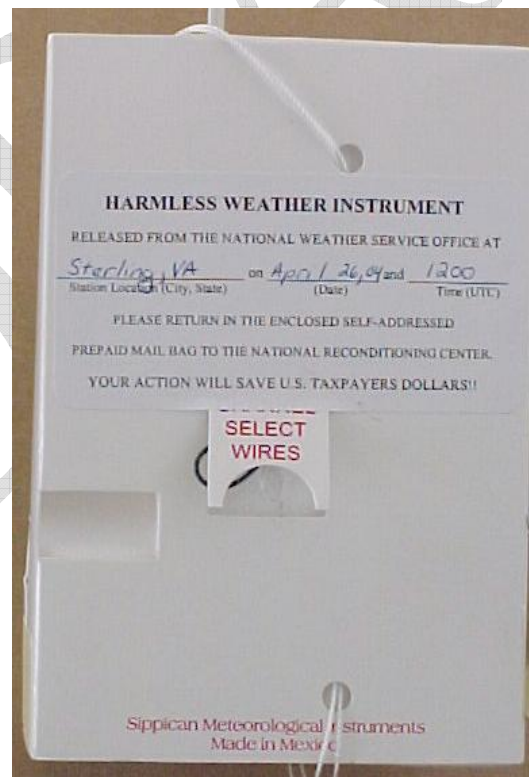


Figure N-17 – Label on Radiosonde

- t. Place the radiosonde on the baseline stand, a styrofoam box or suspend and turn on the GPS repeater. Leave the battery connected to the radiosonde for a minimum of 5 minutes prior to beginning baseline (See Figures N-18 and N-19).

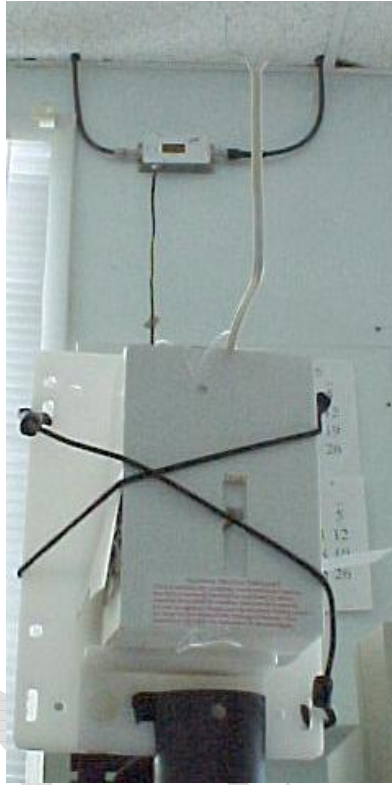


Figure N-18 – Baseline Stand

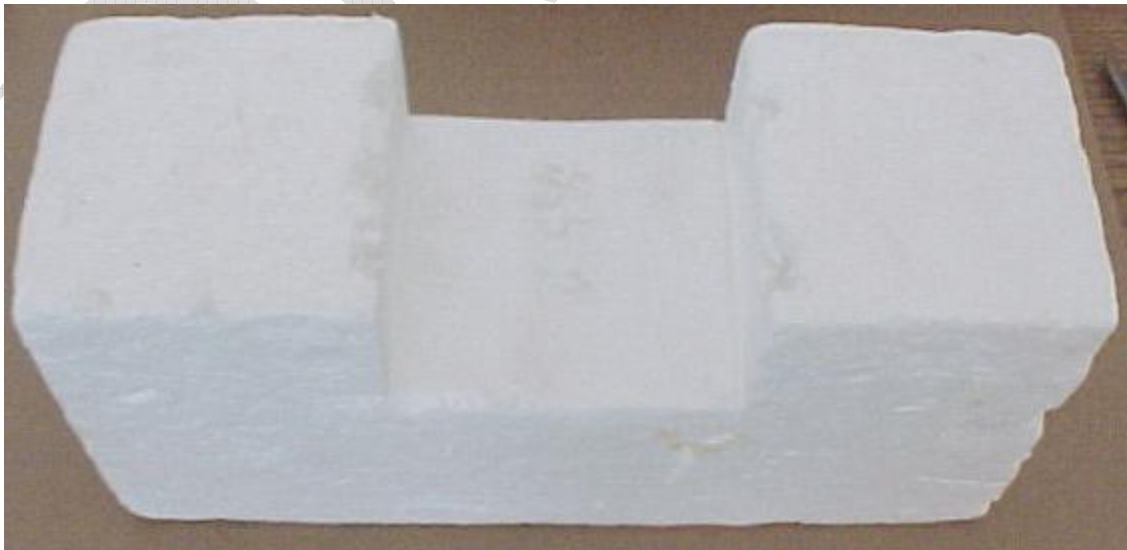


Figure N-19 – Styrofoam Block



**NOTE:** *The MkIIA requires a minimum of 5.6 volts to activate properly. Waiting 5 minutes in Step t. is necessary to bring the battery up to the proper voltage and ensure the radiosondes circuitry is also warmed up.*

- u. After waiting a minimum of 5 minutes, ensure the tracking equipment is set to the same frequency as the radiosonde and check signal strength.

**CAUTION:** *For a 2<sup>nd</sup> or 3<sup>rd</sup> release - Select another frequency - Do not use the “Scan” function to ensure calibration data from the other radiosonde is not used at baseline.*

- v. After ensuring a good strong signal, at least 60 on the Antenna/TRS Display, begin Baseline. If the PTU data or GPS is not received, disconnect the battery from the radiosonde (Disconnect the Positive or Red wire first). Wait 30 seconds then reconnect and restart baseline. This should always be attempted prior to rejecting the radiosonde.

**NOTE:** *The radiosonde starts acquiring satellites once the battery is connected. Nominal GPS acquisition and lock-on times are approximately 2 minutes.*

- w. After the baseline has been completed, the workstation will indicate the radiosonde is ready to be launched. The GPS Status Window should indicate that the radiosonde has achieved lock-on with at least four satellites and the SPS is able to compute position and velocity data for the radiosonde. The workstation will also display pressure, temperature, and humidity data at the bottom of the screen. Verify the Status Bar is receiving the Pressure, Temperature, and Relative Humidity (PTU) data. Point the antenna in the direction the balloon is expected to travel and place the antenna in Manual before leaving the office.

- x. Turn “Off” the GPS Repeater and go to the inflation shelter.

- y. At the inflation shelter, attach the radiosonde to the balloon train assembly.

- z. Ensure the Launch Control Display Unit (LCDU) has a good signal and the antenna can be moved. If the antenna has gone into overload, hold a slew key for “4” seconds to reactivate the motors. The motors will come back in the Manual mode, push the “4” key to put the antenna back in “Auto” track.

- aa. Prior to release, ensure the radiosonde has had a minimum of 20 seconds to reacquire the satellites if it was taken inside the inflation building.

**NOTE:** *The observer must not place the radiosonde on the ground or in contact with solid objects. Doing so will cause GPS lock to be lost and could cause electrical noise or feedback that could adversely affect the signal being received.*

- bb. Carefully release the flight train, taking care not to damage the thermistor during

the release. The instrument should be held at the tie point above the top of the radiosonde.

**NOTE:** *Do not hold the radiosonde at the top or bottom; doing so may adversely affect the performance of the GPS antenna (top) and transmitter (bottom).*

- cc. If using the LCDU, place the antenna in Auto track by pushing the “4” key. If not using the LCDU, upon returning to the office, use the Antenna/TRS Display to place the antenna in the “Search” mode. If GPS is being received, the antenna will move to the last known GPS location. If GPS is not received move the antenna manually to the direction the balloon is traveling and select “Search”. The antenna will start with a “Limited Search” pattern. If the Search pattern goes into “Full Search”, with the antenna elevation going to 90 degrees, stop the “Search” and manually reposition the antenna and begin the “Limited Search” again.

**NOTE:** *If a radiosonde is rejected, immediately replace the hygristor cap on the instrument, replace the sleeve over the temperature sensor, and place it back into the radiosonde package. Fill in the WS Form H-6 for Defective Radiosonde and Batteries. It should be re-inspected by the next observer to re-verify the problem still exists.*

## APPENDIX O – RULES FOR DISPOSAL OF RADIOSNDE BATTERIES AND ACTIVATION IN WATER

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1. **Introduction:** The following instructions will be followed for all NWS Upper Air Sites using radiosondes powered by water-activated batteries. WSH environmental/safety personnel arranged for analytical testing of Vaisala and Sippican batteries and activation water by the ARTECH Laboratory in Chantilly, VA. Three batteries of each manufacturer (Sippican and Vaisala) were exhausted prior to delivery to the laboratory. Approximately half a gallon of tap water was used for activation of each battery.

The Toxic Characteristic Leaching Procedure (TCLP) was performed to determine the appropriate classification of waste. The activation water was tested for pH and copper. Additionally, to replicate some field operational conditions, extended soaks of Sippican and Vaisala were analyzed.

The disposal recommendations apply to all soak types. The TCLP demonstrated that batteries can be characterized as a non-hazardous waste as defined by the Resource Conservation and Recovery Act. The analytical results for chemical tests have been placed on a spreadsheet and compared to applicable regulatory standards. The spread sheet is located on the EASC Environmental Web under Radiosondes. Copies of certified lab results may be obtained from the Regional Environmental Compliance Officers (RECO's).

2. Disposal of Activation Water: These are the rules on how to dispose of battery activation water:

2.1 Sanitary Sewer Options: **Consult the POTW** (Publicly Owned Treatment Works) - If the facility wastewater is being discharged to the local POTW, the Department of Public Works- POTW must be consulted to verify that draining of activation water to the local sewer system is acceptable. The water should be discharged after each battery soak with POTW permission. The lab results for pH and Copper for one soak are available on the web:

<http://www.easc.noaa.gov/enviro/Radiosonde/RADIOSONDEINFO.htm><http://www.easc.noaa.gov/enviro/Radiosonde/RADIOSONDEINFO.htm>

If discharge to POTW is not permitted, proceed with soaking water collection as described in paragraph 2.2.b.

- a. Obtain a written record - The consultation and permission must be obtained in writing and the documentation kept with the environmental files at the Facility. The laboratory results on the web can be used to assist in this consultation.
- b. Pour down the drain.
- c. When using a toilet- lift the toilet seat lid and pour close to the water level. Flush two times.
- d. When pouring down the sink, pour into the sink drain hole and run the tap water for one minute. Take a paper towel and wipe the sink.

2.2 Septic System Options: Disposal into a septic system is not permissible.

- a. Collection - If a septic system is used on site, then the water must be collected in a jug for off site disposal.
- b. Offsite disposal - Coordinate with the closest municipal POTW for delivery and pouring into their system at an alternate location; or disposal through a local contractor. Collection frequency should be established by coordinating with the local POTW or disposal company. Lab results for pH and Copper for 14, 28 and 42 soaks are available on the web site:

<http://www.easc.noaa.gov/enviro/Radiosonde/RADIOSONDEINFO.htm>

- c. Minimize waste water - In the future, the NWS may scientifically validate the switch to alkaline or other types of batteries, which are not water activated.

2.3 Ground Options: Ground dumping of waste is not permitted by NOAA.

2.4 Store Safely: Until disposal, maintain the activation water in a labeled container, with a screw-on lid, placed in a secure spot away from personnel activities and computers.

Radiosonde Battery_____ (name of Battery Type)	
Activation Soak Water: contains copper	
Disposal to approved facility	
POC_____	Date_____

Figure O-1 – Label for Activation Water Container

3. Disposal of Unused Batteries: Batteries which are no longer needed must be managed as Hazardous or Universal Waste. The batteries cannot accumulate or be tossed into the Station dumpster. Collect batteries in a bucket or plastic pail. Mark the Container as indicated in Figure O-2. Store the container in a safe, secure place. Document your accumulation, storage and disposal in a log or in your red Environmental Compliance notebook. File copies of disposal receipts and shipment documents. Required training of the staff can be accomplished by notice or e-mail on the existence of your battery collection program and process.

<b>Batteries for Recycling</b>
Must be disposed of in One Year
POC_____
Date_____

Figure O-2 – Label for Battery Container

4. Applicable Constraints: The consistency of procedure used to activate radiosonde batteries is very important. Activation of batteries will be performed in accordance with manufacturers' instructions. The test results are based on a single battery soaked in approximately ½ a gallon or multiple batteries soaked in approximately one quart of tap water.

Using less than ½ gallon of water for a single soak (when discharge to local POTW) and one quart for multiple soaks (when collected for disposal off site) would alter copper and pH values listed in the Excel spreadsheet.

Further assistance with selection of an appropriate activation water disposal procedure can be requested from NOAA Regional Environmental Compliance Officers (RECO's), NWS Regional Environmental Safety Coordinator, or WSH environmental/safety compliance staff. See Table O-1 page O-4.

**NOAA/NWS CONTACTS NAMES AND PHONE NUMBERS:**

<a href="mailto:daniel.b.mcgoldrick@NOAA.gov">mailto:daniel.b.mcgoldrick@NOAA.gov</a>	<b>EASC RECO</b>	<b>301.713.2870x110</b>
<a href="mailto:Mark.George@NOAA.gov">mailto:Mark.George@NOAA.gov</a>	<b>MASC RECO</b>	<b>303.497.3064</b>
<a href="mailto:Thanh.M.Trinh@noaa.gov">mailto:Thanh.M.Trinh@noaa.gov</a>	<b>WASC RECO</b>	<b>206.526.6647</b>
<a href="mailto:Andy.Poppen@NOAA.gov">mailto:Andy.Poppen@NOAA.gov</a>	<b>CASC RECO</b>	<b>816.426.3925x284</b>
<a href="mailto:Yelena.Platt@NOAA.gov">mailto:Yelena.Platt@NOAA.gov</a>	<b>NWS HQ</b>	<b>301.713.1838</b>
<a href="mailto:Kevin.Murray@NOAA.gov">mailto:Kevin.Murray@NOAA.gov</a>	<b>NWS ER</b>	<b>631.244.0164</b>
<a href="mailto:Terry.Brisbin@NOAA.gov">mailto:Terry.Brisbin@NOAA.gov</a>	<b>NWS SR</b>	<b>817.978.2367x139</b>
<a href="mailto:Kirt.Grahl@Noaa.gov">mailto:Kirt.Grahl@Noaa.gov</a>	<b>NWS CR</b>	<b>816.891.7734x470</b>
<a href="mailto:harold.knocke@NOAA.gov">mailto:harold.knocke@NOAA.gov</a>	<b>NWS WR</b>	<b>801.524.5138x276</b>
<a href="mailto:Ted.Timmons@NOAA.gov">mailto:Ted.Timmons@NOAA.gov</a>	<b>NWS AR</b>	<b>907.271.1557</b>
<a href="mailto:herman.chan@NOAA.gov">mailto:herman.chan@NOAA.gov</a>	<b>NWS PR</b>	<b>808.532.5560</b>

Table O-1 – Environmental/Safety Compliance Contacts